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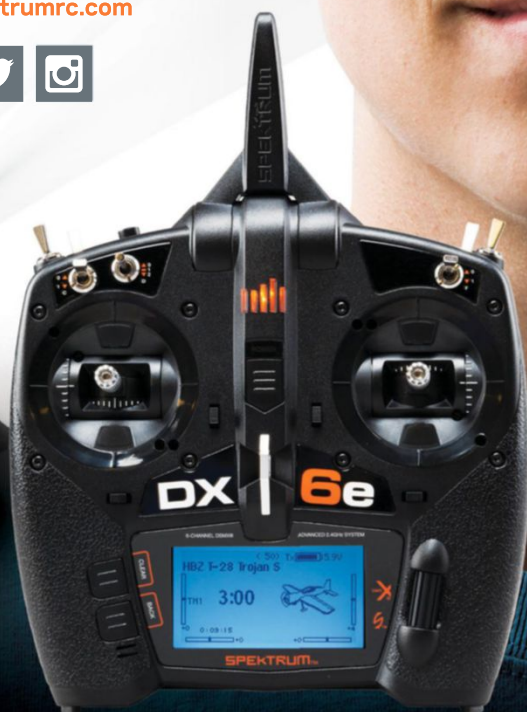
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ON THE COVER: The Freewing Model Avanti S from Motion RC is an ideal first electric jet. Get the inside scoop on this sleek model on page 20. (Photo by Vernon Nelson)

THIS PAGE: It doesn't get much better than flying off a lake, and the FMS Super EZ V2 with floats makes it easy. Don't miss our full review on page 40. (Photo by John Reid)

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Basics and Beyond

It's always good to get back to basics: favorite tools and accessories, fundamental flight techniques, and having a good time at the field. This month, we hope you'll enjoy our compilation of 50 of our favorite field and bench gadgets and accessories. A good tool doesn't just sit on your bench and look pretty, and most of the ones we highlight this month were so well loved that we had to get new ones to photograph! To help you add some style to our flying routine, aerobatic champion John Glezellis shares his advice on how to master three impressive turnaround maneuvers: the half Cuban-8, the tailslide, and the figure-6 with a half-roll down. Also from John, in his Let's Talk Giant Scale column, you'll learn the basics of proper control-surface setup, trimming, and programming, which will result in a better-flying aircraft. In Engine Clinic, nitro-power guru Clarence Lee offers his advice on solving engine failures as well as tips for loosening wristpins and more.

Our reviews this month include a terrific trainer/Sunday flier with floats, a slick and speedy electric jet, an updated favorite fun-fly model, a fast-flying "plank" that's ideal for first-person-view (FPV) gear, and a gem of a World War II model that gives new meaning to micro scale.

If you're in the mood for some RC eye candy, we have just the ticket with a six-page gallery of Lance Campbell's incredible 13-foot-long Lockheed SR-71 Blackbird. You may remember this aircraft from our Top Gun coverage last month, and in this issue, Lance shares all the details on designing, building, and flying the model.

And if basics aren't your thing, we also have plenty of tech, including a roundup of more than 20 of our favorite FPV drone racers. Fair warning to anyone who's interested in trying out FPV racing: It's completely and totally addictive!

We hope you enjoy this issue as much as we did putting it together. I hope you'll take a moment to let us know what you think and what you'd like to see more (or less) of in *Model Airplane News*. Email us at MAN@airage.com or leave a comment on our Facebook page. We look forward to hearing from you!

In this month's feature
"Three Impressive
Turnaround Maneuvers,"
you'll learn the secrets
to fly like these pros.



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We love hearing from our readers: Your emails, tweets, and comments quickly let us know what you'd like to see more (or less!) of in upcoming issues and online. Here's what some of you are saying about *Model Airplane News* magazine.



Facebook The Pros Tell All!

It's always good to learn something new, so we recently posted a great how-to article that included several tips and tricks for building and flying RC airplanes. We asked some of the more experienced big names in the hobby to share some tips. You guys noticed, and here's what you said.

CR: There are some good tips, but I would need a whole article to learn Nick Zirolli's wing-fairing tip.

BM: Mike Greenshields makes some good points. Most of the pilots I know never range-check their planes, and I've seen it cost them. I always, always, always range-check.

JT: I really enjoy reading about engines. Dave Gierke is the best source for two-stroke and four-stroke engine information.

CM: David Scott is spot-on! Coordinating rudder with aileron eliminates adverse yaw, and you don't need a computer radio. Learn to use the rudder!

SE: Thanks to Aaron Ham for showing a great way to start gasoline engines. I always have had a hard time of it. Not anymore.

AB: An excellent article all around. I always learn something on the MAN Facebook page. Thanks!



ModelAirplaneNews.com Understanding Glow Fuel

Ah, the smell of glow fuel in the morning! We recently posted a piece explaining exactly how glow fuel works and what's inside a gallon of this magical go juice that's been such a big part of our hobby of RC model airplanes. Here are some of your comments.

Jesse Lee: I started off with only electrics; now I have a couple of glow planes. I am loving my glow planes more and more each time I fly them.

Mike Maddux: Electrics are clean, but nothing beats the sound and smell of glow engines!

Greg Estrada: I've been doing nitro fuel for 40 years. No match.

Jan Nordhoy: Really good article on glow fuel—finally someone that knows what the nitro is good for in the fuel. It's not about adding power alone, as most think; as you wrote, it's because the engine gets more oxygen and, so, more power. I had a long argument on this in one of the FB groups I'm a member of.

Charles Nott: My first glow engine was a Cox .049 on a Jr. Ringmaster. We would get our fuel from a friend's dad; he mixed his own and used a good helping of nitro.

Cale Gauger: Glow fuel planes just sound cool. All my planes are glow.

Michael Bowman: All I have are glow plugs! And I hand-prop the engine to start.

In Our Mailbox Desktop CNC

I read with interest the review you did of the desktop CNC system in the last issue of *MAN*. I am intrigued. Can you tell me the advantages of a hobby-grade CNC versus a laser cutter? Thanks for the great technical articles—keep it up.—*Scott Michaels, Boulder, CO*

Scott, thanks for writing. I had a lot of fun assembling and learning how to operate the desktop CNC system from Stepcraft. I've run several test jobs with it, and you can see them online at ModelAirplaneNews.com/stepcraft. First off, as with any relatively expensive piece of shop equipment, you first have to define what you actually want to accomplish. If you simply want to build some models, I would not recommend spending the money if, in the end, you could do the same tasks with a band saw. If, however, you are interested in producing multiple precision parts, then the investment is valid. Having both a 40-watt hobby laser cutter and the CNC, I've learned that both are useful and each has its own advantages. For thin wood stock, like balsa and light plywood (up to 1/4 inch thick), the laser cutter can produce a lot of parts quickly. To cut thicker wood, you need to invest in a more powerful laser cutter in the 90- to 100-watt range. Also, it is great for engraving wood and cast-acrylic awards and plaques. If you want to do more and produce much thicker parts—like 1/2-inch-thick firewalls, 1/4-inch plywood formers, 1/8-inch plywood wing ribs, and other load bearing parts—then a three-axis CNC is the way to go. Plus, if you want to cut and machine other materials like carbon fiber, aluminum, and brass sheet materials, then the CNC wins hands down. My hobby laser won't even dent these materials.—GY



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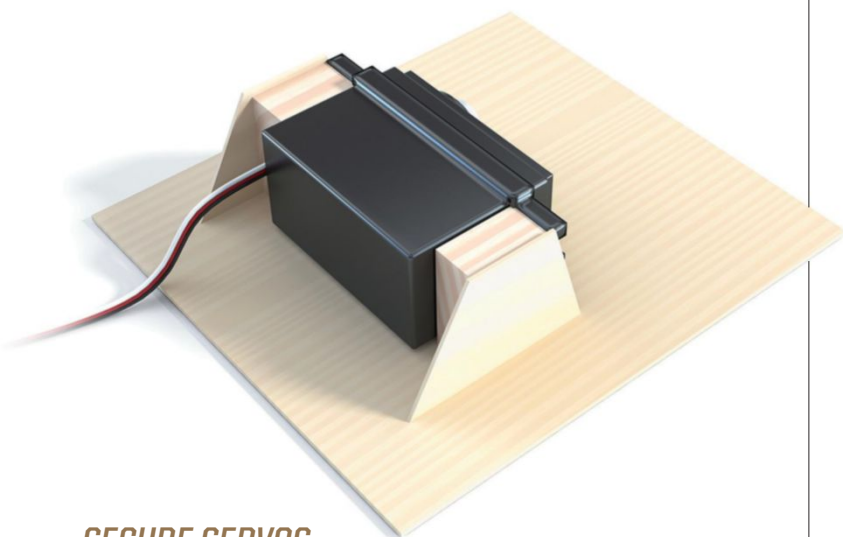
You know it's Summer when Multiplex delivers two new fun-flying models for ultimate outdoor adventure. The sporty, compact FunGlider offers exhilarating sailplane aerobatics with flight times of up to 20 minutes, while the Extra 330SC powerhouse, designed by World Champion Gernot Bruckmann, brings impressive durability and agility to the most dramatic 3D maneuvers. **Nothing beats a Multiplex Summer!**



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Tips & Tricks

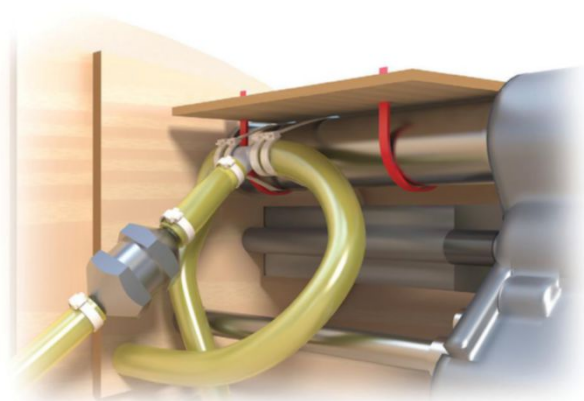
USEFUL HINTS FROM MODELERS | Illustrations by Richard Thompson



SECURE SERVOS

With large and giant-scale airplanes in which the aileron servos are secured under flush-fitting hatches, I replace the typical 3/8-inch-square spruce mounting rails with thicker and wider support blocks. If there's enough room, I double the width to 3/4 inch and make them about 1/2 inch wide. Plus, I use thin light plywood to add reinforcement gussets to secure the rails. I also use 15-minute epoxy instead of CA glue for a sturdy glue bond.

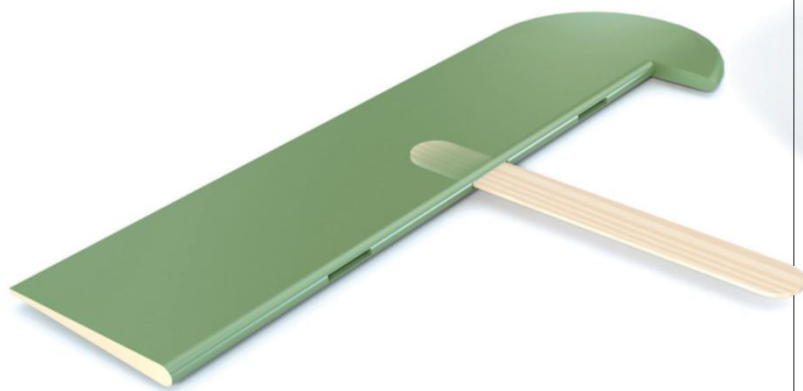
Craig Williams, Pittsburgh, PA



GAS-LINE CONNECTIONS

After flying giant-scale airplanes for years, I have started to use cable ties to secure connections to both T-fittings and inline filters installed in Tygon fuel tubing. I also use cable ties to secure the T-fittings that lead to my fuel dot to a sturdy anchor, such as the engine standoffs. This takes stress off the fitting and prevents the fuel lines from chafing on sharp edges while the airplane is in flight.

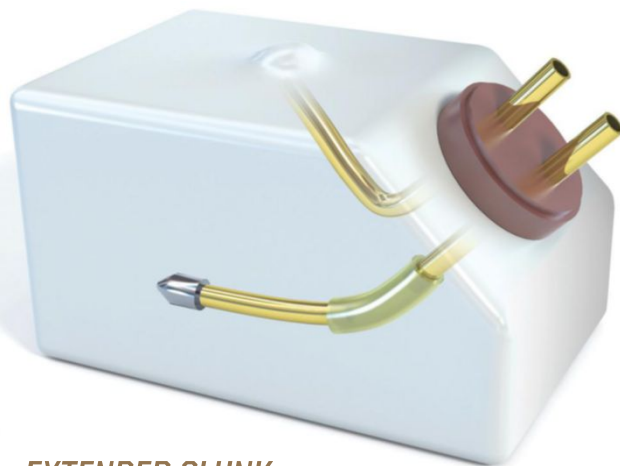
Chris Murphy, Gainesville, FL



PAINT STICKS

When it comes time to finish and paint my model's control surfaces, I use a wooden Popsicle stick inserted into one of the hinge slots so that I can hold the surface while I spray-paint it. This keeps my hands a lot cleaner, and if you use a stick in each hinge slot, you protect the inner surface from the paint; that way, you get a more secure bond when you glue your hinges into place.

Sal Calvagna, Holbrook, NY



EXTENDED CLUNK

I learned a long time ago that if your model noses over during a dead-stick landing, the fuel pick-up clunk inside the gas tank could be forced to the front of the tank. This leads to another dead-stick flight when you climb out during the next takeoff, as the engine is starved of fuel during the nose-up climb. I solder a length of 1/8-inch brass tube to the clunk and then attach it to the tank outlet tube with a short piece of flexible tubing. This setup allows the clunk to move freely while preventing it from being forced to the front of the tank. This simple fix works great.

Jim Newman, South Lafayette, IN



SEND IN YOUR IDEAS! We want your ideas for Tips & Tricks! This month's winners will receive a *Model Airplane News* baseball cap. Send a photo or rough sketch and a brief description to MAN@airage.com or *Model Airplane News*, c/o Air Age Media, 88 Danbury Rd., Wilton, CT 06897 USA.

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MiG-15

Mickey Snelson, Bixby, OK

Sporting a Polish Air Force scheme, this vintage Byron jet was modified for an electric 120mm Jetfan built by Efflux running on a 12S pack. Mickey also modified the servo locations and sheeted and fiberglassed all the foam parts. Spring Air retracts, Callie Graphics decals, and a scratch-built cockpit are the finishing touches to a great-looking aircraft.

PILOT
PROJECT
OF THE
MONTH



Piper Cub

Terry Ziegler, Moline, IL

After saving this SIG 1/4-scale Cub from the dumpster, Terry stripped it down, repaired it, then added functional doors, Solartex covering with wing stitching, and Robart bungee gear. A DLE 35RA spinning a Falcon prop provides the get-up-and-go.



PBY Catalina

Michael Rogozinsky, Toronto, ON, Canada

This 6-foot-wingspan Catalina PBY flying-boat model by Aeronaut is powered by two 15-size brushless motors and a 3-cell LiPo, and it's finished in vintage Canadian colors. Michael writes that he spent six months building it and that its first flight was "flawless."



F4U Corsairs

Michael Deuter, Joline, IL

Built from Ziroli Plans, both of these bent-wing warbirds have 92-inch wingspans and are equipped with functional flaps. Michael also equipped each of them with fixed gear, MonoKote covering, a DLE 44cc gas engine, and Tru-Turn prop hubs.

SEND IN YOUR PICTURES! *Model Airplane News* is your magazine, and we encourage reader participation. Email your high-resolution images to MAN@airage.com, with your contact information and details on your project. Every pilot we feature will receive a *Model Airplane News* baseball cap, and the "Pilot Project of the Month" winner will receive a *Model Airplane News* "swag pack."

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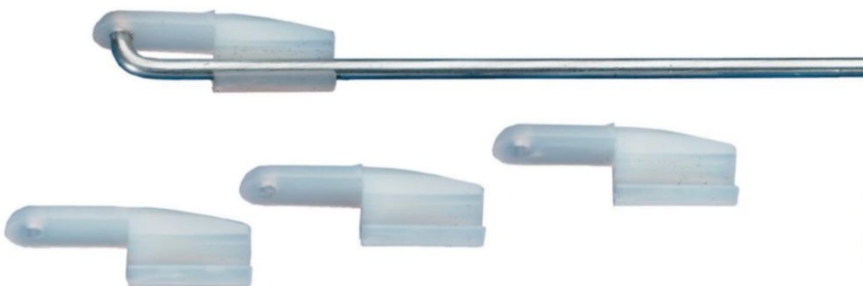
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E-flite X-VERT

This park flier's simple, tail-sitter design and SAFE technology make it easy for pilots to enjoy its amazing VTOL flight capabilities. The ready-to-fly model makes the transition between multirotor and airplane flight as easy as flipping a switch. For even more fun, add the optional patent-pending, servo-driven FPV camera mount that automatically transitions your FPV camera from airplane to multirotor flight. The Bind-N-Fly X-VERT is \$149.99; the ready-to-fly version is \$199.99. e-fliterc.com

Graupner Stolp Starlet 2400

A scale model of the experimental home-built plane, this model has docile flight characteristics, making it an ideal first giant-scale project. It's intended for an O.S. GT 33 or glow or electric equivalent and has easy access to the fuselage beneath the canopy. This 94.4-inch-span ARF costs \$590.90. graupnerusa.com



Blade Stealth Conspiracy 220

An upgraded, limited-edition version of the stock Conspiracy, this race-ready/freestyle quad comes expertly tuned and features a 4mm-thick carbon-fiber main frame. It features a Spektrum FC3207 F3 flight controller, new Thrust 2206-2450Kv motors, and upgraded 30-amp speed controls. Its onboard camera and 200mW video transmitter provide a clean video signal to compatible 5.8GHz headsets/monitors, and three progressive flight modes make it easy learning to fly FPV. The Bind-N-Fly Basic model is \$379.99. bladehelis.com



Graupner Jodel Robin DR 400

Intended for gas or electric power, this 98-inch-span, built-up model is covered in UltraCote. It's a very stable flier that comes fitted with an aero-tow coupling, which makes it an ideal towplane. The Jodel Robin's removable wing halves make it easy to transport, and its ailerons, rudder, and elevators have a locking design. The Jodel Robin costs \$599.90. graupnerusa.com



FMS 90mm Super Scorpion

Ideal for paved or grass runways, this fast flier will definitely turn heads with its vibrant color scheme. It features functional flaps; a 90mm 12-blade electric ducted-fan system; CNC-processed, shock-absorbing retracts; and digital metal-gear servos. Add your receiver and 6S pack and put on a show! The 90mm Super Scorpion costs \$449.99. forcerc.com



Multiplex FunGlider

With Elapor foam construction and a powerful brushless motor, this compact sport glider can perform exciting aerobatic moves as well as slope-soar and grab thermals with the best of them. Assembly is as simple as pushing the wing halves and tailplane into place. The 51-inch-span receiver-ready model is \$179.99. weekenderwarehouse.com



Flightline RC 1600mm Spitfire

Scale enthusiasts will find a lot to love about this new foam warbird, from its outline to its scale suspension struts, four-spoke wheels, and four-panel split flaps with ribbing detail. It also has LED wingtip lights, and an installed dorsal signal light can be plugged into the circuit board to flash intermittently. It comes with an installed powerful brushless power system and digital metal-gear servos on all control surfaces. You just need a radio, receiver, and a 6S 4000 to 5000mAh battery. This 63-inch-span warbird will cost about \$340.00. motionrc.com



RBckits Skyray

An ideal building project, this 90mm electric or turbine jet kit features CNC-cut formers and ribs with a tab-lock design that makes building more enjoyable. Full-size rolled CAD plans show all parts, and an included CD has photo-illustrated instructions. A vacuum-formed canopy, fairings, and a nose cone are included. This F4D kit costs \$195.00. rbckits.com



Phoenix A-26 Invader

When was the last time you saw an RC A-26? This unique warbird is designed for two 46 to 55cc gas engines or electric equivalents, like RimFire .32s. Built of balsa and ply, it features two-piece functional flaps, air retracts, fiberglass cowls, and a one-piece canopy with painted frame lines. A fully detailed cockpit with painted-bust pilots is also included. This 90.5-inch-span twin ARF costs \$429.99. towerhobbies.com

E-flite/ Horizon Hobby UMX F4F Wildcat

This small warbird is big on scale details and performance

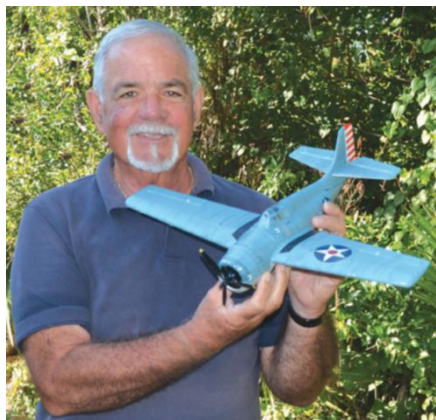
TEXT & PHOTOS BY RICH URAVITCH



E-flite has introduced its latest offering in a growing line of UMX RC models that employ the now familiar AS3X stabilization system, which, like a gyro, allows a small lightweight aircraft to be safely and comfortably controlled in wind conditions that would keep even larger, nonstabilized models grounded. Not that you would *want* to fly these diminutive cuties in conditions that would require full throttle to maintain zero ground speed—only that you *could*. And the system really does work!

This model, like most of its predecessors, has a molded foam structure, is one piece, and comes predecorated with all paint and markings. It's made out of injection-molded foam, much like the larger foam models we see today. This adds fractionally to its all-up weight, but damage potential seems to be significantly less. What you get in the box is a Bind-N-Fly airframe to which you'll only need to add a 2S 280mAh LiPo battery to start flying over your local version of Guadalcanal looking for Zeros! The landing gear is included, and it's preinstalled but removable.

Potential pilots of the Wildcat should be comfortable flying a 4-channel model, probably placing them in the "intermediate" category, but I have no doubt newer fliers could handle it, with some initial help looking over their shoulder during trim flights.



AT A GLANCE

	MODEL UMX F4F Wildcat
	MANUFACTURER E-flite (e-fliterc.com)
	DISTRIBUTOR Horizon Hobby (horizonhobby.com)
	WINGSPAN 20.3 in.
	PILOT SKILL LEVEL Intermediate
	ASSEMBLY TIME None
	RADIO REQ'D 4-channel DSM2/DSMX-compatible
	POWER REQ'D 2S 280mAh LiPo
	PRICE \$129.99

WHAT WE LIKE

- + Durable, molded foam structure
- + Ready to go out of the box
- + Comprehensive instruction manual
- + Removable main landing gear





INCLUDED IS A INSTRUCTION MANUAL THAT GOES INTO EVERY SETUP DETAIL YOU MIGHT ENCOUNTER, INCLUDING RECEIVER ARMING AND GETTING THE CENTER OF GRAVITY CORRECT; IT ALSO INCLUDES A HANDY "FIRST FLIGHT" CHECKLIST AND A COMPREHENSIVE "TROUBLESHOOTING GUIDE," WHICH ANSWERS EVERY PROBLEM OR DIFFICULTY YOU'RE LIKELY TO ENCOUNTER.



The battery pack and the motor are easy to get to under the removable cowl.

UNIQUE FEATURES

As an ultimate ARF, there isn't anything to assemble since it's really bind-and-fly, but I did thoroughly inspect the model before I took it out to fly. I really like the easily removable landing gear. This model, like many others, benefits in appearance when the gear is retracted. I notice no difference in flying qualities, probably because the weight of the gear was negligible and close to the center of gravity anyway.

The spinner is molded plastic, soft and glued into place on the prop hub, and there is nothing to true-center it on the prop. Mine was a little off, which became apparent the first time I powered up the motor. It didn't affect performance at all but looked funny running out of round. After a nose-over landing, it *really* became out of round, so I removed it after unsuccessfully trying to glue it back in place in a centered position. I haven't bothered to replace it. While we're at the propulsion end of the model, I've got to let you know that the scale-looking 3-blade prop looks great and also works well with the provided motor

and battery, but be careful. If you break it, it's going to set you back about \$7 for a replacement.

IN THE AIR

The first flights of my Wildcat took place at our club site, where we're fortunate enough to have prepared concrete surfaces for takeoffs and landings. I left the model as supplied, with the landing gear in place (extended position). There is a significant and visible amount of both right and down thrust built into the motor-mounting surface, and those thrust settings do exactly what they're supposed to do, especially when



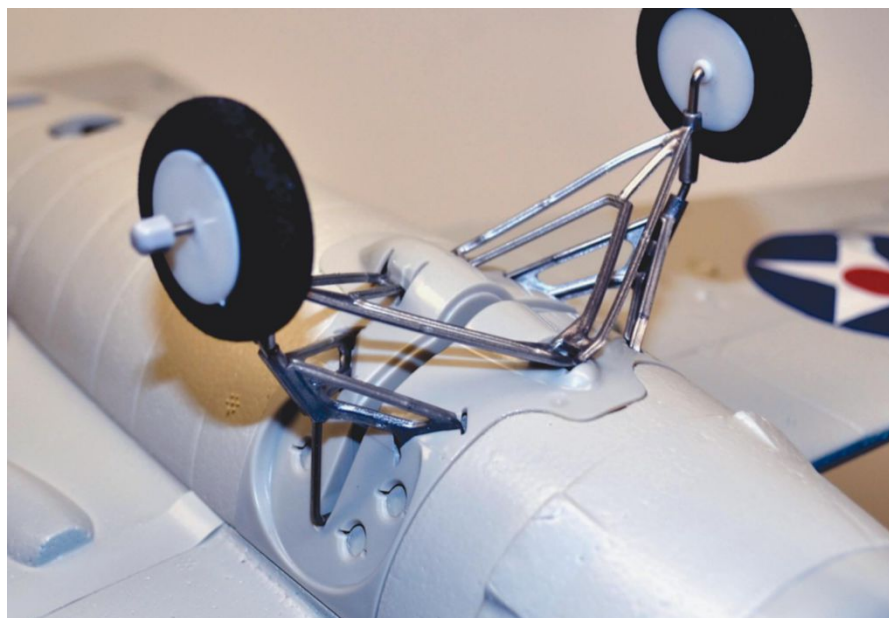
These openings in the belly provide cooling for the motor and speed control.

applying power for that first takeoff. I needed no right-rudder correction after applying power. The model accelerated, its tail came up, and it was airborne in about 15 feet, climbing out smartly. I preset the dual rates on aileron, elevator, and rudder to 100% (high) and 70% (low), per the manual, and ended up flying it in low rate most of the time. The manual provides no recommended setting for the "Expo," but given the fact that it is a small model, I set it to 75% and it felt just fine. There didn't seem to be any power-trim change, so I guess the offsets of the motor I mentioned earlier were right on the button.

GENERAL FLIGHT PERFORMANCE

Stability: All trimmed up, the Wildcat can practically fly hands-off.

Tracking: At full throttle, it's pretty fast—visually, a little too fast. (Had the full-scale



The scale-looking landing gear are removable. You can fly with them in place for ground takeoffs or remove them and hand-launch the Wildcat.

GEAR USED



RADIO

Spektrum DX6 (spektrumrc.com)



MOTOR

BL180 3000Kv brushless outrunner (installed)



PROP

3-blade (installed)



BATTERY

E-flite 2S 280mAh LiPo (e-fliterc.com)

The First Feline Fighter

The Grumman F4F Wildcat was developed in the mid-1930s as a logical continuation of Grumman's interest in continuing to build its reputation into the naval-fighter business. Perhaps they wanted to stop building biplanes, saw a war looming on the horizon, had a shortage of the F3F fabric wings anyway, so they took the F3F fuselage and made it a monoplane with metal wing. It was the first of a long and famous line of Grumman "cats" that ended with the arguably best fighter ever: the F-14 Tomcat.

Much of the F3F's influence can be seen in the Wildcat: stubby little fuselage; big, round motor; and a retractable main-gear system that would be more likely seen on a carnival Ferris wheel. For all its shortcomings, the Wildcat still represented



progress in the fighter world, and the evolution continued with the F6F Hellcat and brutish F8F Bearcat, followed by the Panther, Cougar, Jaguar, Tigercat, Tiger, and Tomcat! Lots of feline fighters!



The photo at far left is of the model straight out of the box. At near left, you can see the difference that a little weathering makes.

Wildcat been proportionately this fast, there would have been no need to develop the Bearcat!) The AS3X system works well, correcting for gusting wind conditions when necessary.

Aerobatics: Most aerobatic maneuvers were easily performed including loops, rolls, and any typical warbird maneuvers.

Glide and stall performance: Landings are easily done; the model slows down nicely and seems to prefer three-point arrivals as opposed to wheel landings.

PILOT DEBRIEFING

The narrow-track landing gear makes you

tend to avoid long rollouts and taxi back; remember this warbird only weighs 3.7 ounces, ready to fly. To avoid issues taxiing, including the "wingtip rash" potential, simply remove the landing gear per the instructions, put the dummy covers in place, and hand-launch it,

then land in grass or a smooth dirt surface. The Wildcat looks much better in the air without the gear, anyway. Overall, the UMX Wildcat flies and handles like a larger model and one with which you can easily become comfortable.

BOTTOM LINE

As I've said, with nothing to build, you're almost ready to go when the Wildcat gets to your door. A multipage, multilingual instruction manual is included, and it goes into every setup detail you might encounter, including receiver arming and getting the center of gravity correct; it also includes a handy "First Flight" checklist and a comprehensive "Troubleshooting Guide," which answers every problem or difficulty you're likely to encounter. ✚

Freewing Model Avanti S







Join the jet set with this sleek, plug-and-play flier

BY JOHN KAUK PHOTOS VERNON NELSON & JOHN KAUK



Having recently developed an interest in electric ducted-fan jets, I started casting about for an easy, relatively inexpensive sport plane to get started. I wanted a plane that would be easy to fly yet still be fast and fairly aerobatic. I asked several friends what would be a good introductory jet and a couple of them pointed me to the Motion RC website (motionrc.com), where a preorder had just been opened for the Freewing Avanti S.

AT A GLANCE

	MODEL Freewing Avanti S PNP
	MANUFACTURER Freewing Model
	DISTRIBUTOR Motion RC (motionrc.com)
	WINGSPAN 48.7 in.
	POWER REQ'D 6S 4000-5000mAh LiPo
	PRICE \$329.00

WHAT WE LIKE

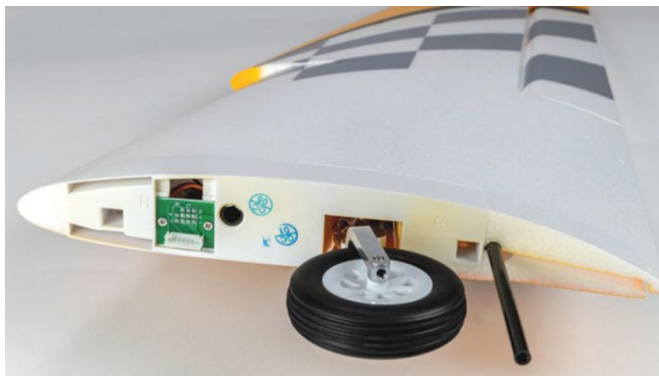
- + Fast, easy assembly
- + Effective trailing-link gear struts for rough field use
- + Outstanding design features throughout
- + Good looks and great "jet" sound

The low parts count and good fit make for quick assembly. The bag of small parts includes a tube of glue for attaching the tinted plastic canopy to the cockpit hatch.



FREEWING'S AVANTI S HAS TURNED OUT TO BE JUST THE PLANE I WAS HOPING FOR. IT CAN BE ASSEMBLED QUICKLY, IN AN HOUR OR SO. IT'S STABLE AND HANDLES WIND VERY WELL.





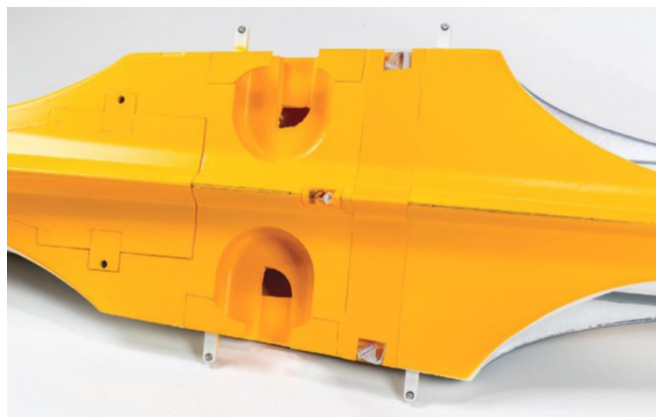
At the rear of the wing root is a carbon-fiber subspar for additional strength. The molded plastic root is sturdy, and just forward of the main spar tube a connector circuit board is mounted. This makes connecting everything in the wing an easy, one-step operation.



Big wheels, electric retracts with sturdy aluminum struts, and trailing-link suspension on all landing gear make the Avanti S well suited to grass- and rough-field operations.



The fuselage wing roots show some attention to detail. The wheel well is big enough to accept the wheel in its retracted position, making assembly easier. Wing servos and lights are connected by a seven-wire ribbon cable.



The bottom of the fuselage has a plywood keel molded into the foam for added ruggedness. The large hatch at the left is where the fan unit is installed. Also visible are the four wing retainers, the red LED, and the two ribbon cables for lights, retracts, and servos.

Freewing's Avanti S is an officially licensed version of SebArt's turbine-powered Avanti S designed by Sebastiano Silvestri, a model that's fairly well known in RC aerobatic competition. Constructed out of molded EPO foam, powered by an 80mm EDF on a 6S LiPo battery, with electric retracts and a full set of running lights and beacons, Freewing's version is an attractive airframe.

I found a few demonstration-flight videos online and thought the model looked just about perfect for my wants, so I signed up for the preorder. A plug-and-play model, there's not a lot needed to get it flying, just a radio system and

battery. I have plenty of suitable 6S batteries, and a quick search through the radio parts box yielded a Spektrum AR9350 receiver that I knew would work well, so I was set to go.

UNIQUE FEATURES

When the Avanti S was finally delivered and unboxed, I was surprised at the low parts count. The airframe is beautifully molded, smooth, well-finished EPO foam. The color scheme is well done, some of it in paint and some in decals, all fairly well matched and applied. The power system, retractable landing gear, and servos are all installed, and the flying surfaces are hinged and ready to connect. The battery and radio compartment access hatch is large, attached to the fuselage by both strong magnets and a latch at the rear. It's covered by the canopy, which is formed out of tinted clear plastic and covers a basic cockpit that can be detailed if desired.

The first thing I did was to avoid having to find and install a pilot figure by painting the inside of the canopy black. I don't like a clear canopy on a model with no pilot, and the black canopy looks sharp and fits with the overall color scheme. While the paint dried, I laid a towel on the workbench to protect the foam finish and started assembling the airframe.

The installation of the stabilizer and the fin assemblies goes quickly. Snake the servo wires

forward into the radio compartment and fit the parts into place; four bolts hold each of them securely. It couldn't be easier. The two wing panels with the retracted landing gear are next. There are three carbon-fiber tubes in the wing: one glued in the aft part of each wing panel and a longer one that acts as a spar. With the spar tube inserted through the fuselage, the wing panels slide into place easily. A notable design point is that the retracted landing gear fits easily into the fuselage through a hole in the wing root big enough for the wheel. Wing-panel servos, lights, and landing gear are connected to the radio by way of a seven-wire ribbon cable—clean and easy. When it's all together, four screws hold the two panels in place. That's a total of only 12 screws to assemble the whole airframe.

The next step is installing the receiver. All the servo leads come together in the forward part of the battery compartment, where they're plugged into a control board. Six leads for the receiver connections are factory installed and marked, so it's a simple procedure to plug them into the proper channels in the receiver. The instruction manual gives basic settings for the control throws, which have worked well for me. To finish the assembly, I used the supplied glue to attach the freshly painted canopy to the hatch cover and taped it in place overnight.

GEAR USED



RADIO

Spektrum DX9 w/ AR9350 receiver (spektrumrc.com); eight 9g digital metal-gear servos (installed)



MOTOR

80mm 12-blade electric ducted fan, 3530-1800Kv outrunner, 100A speed control w/ 5-amp BEC (all installed)



BATTERY

Pulse 6S 5000mAh LiPo (pulsebattery.com)



FMS 1220mm SUPER EZ V2

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REASONABLE PRICE FOR BEGINNERS!

- Motor size: Brushless 3136-KV1200
(compared to V1 with KV1050)
- Recommended Battery: 11.1V
1300-2200mAh 25C
- Servo: 9g Waterproof Servo x 4

\$179.99 PNP
(WITH FLOATS)



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ASSEMBLY

Multi-connector for easy installation

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(WITHOUT FLOATS)



IN THE AIR

When I got out to the field for test flights, weather forecasters had missed their wind prediction by a considerable margin. What I expected to be fairly calm conditions had turned into 15mph and gusty, ranging from straight down the runway to directly crosswind—"normal weather" in other words (this being Kansas).

I installed a Pulse 6S 5000mAh battery, powered up, and checked the flight controls. Everything looked good, so I headed out to the runway. As the Avanti S accelerated on the takeoff run, it tracked straight, with little need for correction except for bumps. As it neared the end of the runway, I started feeding in up-elevator, and after a moment, the plane jumped up into the air. It climbed out with authority and only needed a small amount of up-elevator trim. Aileron turns were easy—no rudder input necessary. I flew a couple of circuits around the field and quickly became comfortable with the plane. The first roll was crisp and surprisingly quick, but it didn't feel scary. A big, whooshing loop put a smile on my face just before the four-minute flight timer reminded me it was time to set up for landing.

With the gear down and flaps fully extended and coupled with about 5% down-elevator mix, the Avanti S slowed down nicely, still feeling solid. The landing approach was stable in spite of the crosswind, but a too-early flare led to a bumpy first landing. The well-sprung landing gear absorbed the worst of it, fortunately, and the neat breakaway nose cone prevented any damage to the plane. I got in six flights that day, and each one was a little more satisfying than the previous one. My landing skills improved as well as I learned to keep some power on until just before the final flare.

GENERAL FLIGHT PERFORMANCE

Stability: Balanced within the recommended range, the Avanti S is stable and inspires confidence. It's hard to get it to do anything unexpected, and if it does, relaxing the control sticks usually allows it to recover on its own.

Tracking: I hate to use all the clichés, but the Avanti S really does track like it's on rails—on the ground and in the air. At high speed, it's smooth and predictable, and low-speed tracking is just about as good. It goes where you point it—reliably.

Aerobatics: Fun, fun, fun! This plane accelerates quickly and sounds great doing it. It's got abundant power for big, impressive loops and long vertical lines. At the recommended throws, the ailerons are quick, and the roll rate is impressive. I like to fly it balanced at the rear of the recommended balance range—about 110mm—where inverted flight requires just a touch of down-elevator correction. Fast knife-edge flight also requires just a little top rudder to stay on line.

Glide and stall performance: I couldn't make the Avanti S exhibit any bad behavior at low speed.



Above: With the wings mounted, the close-fitting landing-gear doors and other parts are plain to see. There are clear plastic viewports over the ribbon wire connectors, making it easy to confirm good connections.



Left: As seen on the fin and rudder, all flying surfaces have nylon pinned hinges. The metal-gear servos are connected to the surfaces with sturdy brass ball-link hardware.

When it stalled, it simply dropped its nose, and adding a little power had it flying again. Power off, with its sleek shape, it glides fairly well. Full flaps make it a bit floaty, so keep a touch of power on when landing.

really enjoy the big, whooshing jet sound when the Avanti S is flying through a big loop or doing a long slow roll down the center of the runway. With its excellent stability, it has certainly made me a believer in flying electric ducted fans, and I'd recommend it to anyone as a first jet.

PILOT DEBRIEFING

Did I mention that this is a fun model to fly? I

BOTTOM LINE

Freewing's Avanti S has turned out to be just the plane I was hoping for. It can be assembled quickly, in an hour or so. It's stable and handles wind very well. While it can be fast and aerobatic, it slows down nicely and lands easily. The trailing-link landing gear and large wheels handle rough grass runways with no problem. At my field, the grass can be a little long, and it caused the nose-gear suspension to compress a little as speed increased, bringing the nose down. I found that a little flap deflection and holding some up-elevator on the takeoff run helped achieve a smooth liftoff. ±

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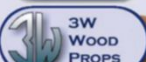
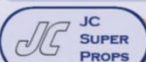


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50 FIELD AND BENCH FAVORITES

TOP EDITORS' PICKS FOR RC ACCESSORIES

BY THE MODEL AIRPLANE NEWS CREW

When it comes to getting our aircraft from the workbench to the flying field, there are lots of tasks and adjustments involved. Then before we can get our planes airborne, there are a few special support-equipment items needed to crank up the engine or motor. This field and bench guide includes 50 of our editors' favorite tools, gadgets, and equipment that make our hobby easier to enjoy and allow us to have more fun in the process. From must-have workbench items and flying field favorites, we're sure that you'll find something here that you'd love to add to your toolbox.



Du-Bro Large Scale In-Line Fuel Filter

A must-have item for all giant-scale modelers, these large in-line fuel filters are constructed of two threaded aluminum parts housing a 130-micron mesh filter. An O-ring seals the filter against leakage. It works with both gasoline and glow fuels.

\$4.08 | shop.dubro.com

Zap-a-Gap Single-Use Tubes

Ever break something at the flying field and need just a little glue? Now packaged in five 0.01-ounce (0.5g) single-use tubes, you can now use Zap-a-Gap CA+ glue a little at a time whenever you need it. It's ideal for the flight box or the workshop.

\$4.99 | zapglue.com

Futaba BR-3000 Battery Checker

Great to keep in your flight box, the Futaba BR-3000 battery checker quickly displays voltage levels of battery packs. It shows the total voltage and remaining capacity on a bar graph and as a percentage. It can be used with 2- to 7-cell LiFe, LiPo, and Li-Ion packs as well as 4- to 7-cell Ni-Cd and NiMH packs.

\$49.99 | futabarc.com

Hitec RCD X2-700 Multicharger

The Hitec X2-700 is a multichemistry, microprocessor-controlled DC-powered charger that's actually two independent chargers in one package. Each side of the charger is capable of up to 700W of output power with the appropriate power supply. Capable of charging Ni-Cd, NiMH, and lead-acid batteries, it can also charge and maintain a variety of lithium-battery chemistries, including lithium polymer (LiPo), lithium ferrite (LiFe), lithium ion (Li-Ion), and the new high-voltage LiPo (LiHV) cells. Synchronous mode allows both sides of the charger to be set, using the controls on side one, for charging two identical batteries. Up to 10 battery profiles can be stored. With two displays and only four buttons for each side, the X2-700 is simple and intuitive to use. With a 12V source, each side of the charger puts out up to 350W. The full 700W-per-side output power requires a 24V power supply. Well designed, it is a capable solution for those who need a higher-power charger.

\$199.99 | hitecrd.com





BSI Foam-Cure Glue

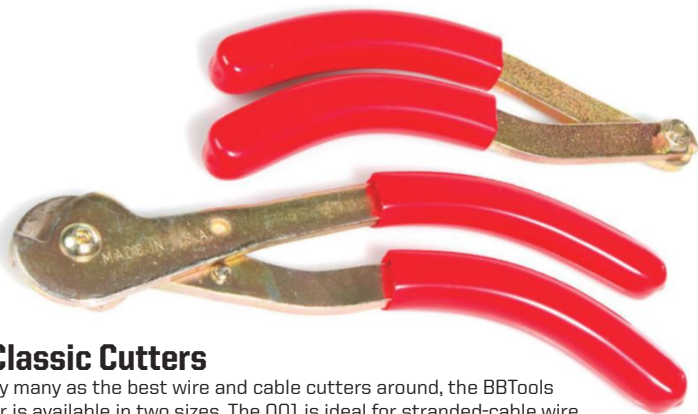
A silicone-based adhesive, BSI Foam-Cure works very well on EPP and EPO foams. Crystal clear, it forms a more flexible consistency than CA. It is, however, not an instant-bonding glue and has no accelerator to speed cure time.

\$6.23 (4 oz.) | bsi-inc.com

AeroBroach Hinge Slot Cutter

Including three popular sizes, these slot cutters are easy to use. The "CA" broach is for use with thin CA-type hinges. The ".60" broach is for standard pinned hinges for up to .60-size airplanes, and the "1/4" broach is for heavy-duty, two-piece pinned hinges used in larger 1/4-scale airplanes.

\$17.95 | aerobroach.com



BBTools Classic Cutters

Considered by many as the best wire and cable cutters around, the BBTools Classic Cutter is available in two sizes. The 001 is ideal for stranded-cable wire up to 3/32 inch in diameter and can cut music and piano wire up to 5/64 inch in diameter. The 002 is perfect for cutting stranded-cable wire up to 3/16 inch in diameter and cuts music and piano wire up to 1/8 inch in diameter.

\$16; \$18 | bbtools.net



Smart-Fly Ignition Cutoff

Designed for planes with a single receiver, the Smart-Fly Ignition Cutoff unit has two modules that are connected by a fiber-optic cable, providing safety and convenience for your gas-powered plane. The unit isolates your radio system from your ignition system and works off a transmitter switch. It requires a separate channel to operate it.

\$49.95 | smart-fly.com



Cal-Grafx RiveterPro

A new twist on a classic scale-modeling technique, the new RiveterPro makes applying evenly spaced, consistently sized, glue-droplet rivets easier than ever. It consists of prepunched masking strips and a bottle of Rivet Applicator fluid. Available in three sizes of rivet diameters and spacings, cured rivets have the best appearance after painting. The sampler kit includes a bottle of applicator fluid and a three-strip of each size.

\$29.95 | cal-grafx.com



Dremel Model 4300 Rotary Tool

Compatible with all Dremel attachments and accessories, the Dremel Model 4300 Rotary Tool, with its universal three-jaw chuck, doesn't require additional hand tools to change tool bits. The Dremel 4300 features an all-new pivot light, which provides illumination even in difficult-to-reach spaces. Additionally, the tool features built-in variable speed and electronic-feedback circuitry to keep the tool running at peak performance. The Standard Edition includes five attachments and a great all-around selection of 40 genuine Dremel accessories. The deluxe storage case holds the tool, attachments, and accessories to keep everything together.

\$119.99 (Standard Edition) | dremel.com

Du-Bro Tru-Spin Prop Balancer

One of the most precise balancers available, the Tru-Spin Prop Balancer features a specially designed locking cone to securely center and lock the prop on the balancing shaft. For use with airplane props as well as spinners, helicopter rotor heads, ducted fan jet impellers, and flywheels, each balancer comes complete with assembly instructions and prop-balancing tips.

\$39.14 | shop.dubro.com



Du-Bro Kwik-Start XL Glow Driver

Ideal for all types of standard glow plugs, the long-reach Kwik-Start XL Glow Driver securely attaches to the glow plug to reliably start glow engines. It comes complete with a Kwik-Mount Storage Klip and wall charger.

\$26.73 | shop.dubro.com



Du-Bro Kwik-Fill Fuel Pump

No battery required, this hand-operated fuel pump works with gasoline and glow fuel and comes with silicone fuel tubing (for gasoline, replace with gas-grade Tygon tubing). A Kwik-Fill Fuel Cap Fitting, mounting chain, and pickup are also included.

\$24.26 | shop.dubro.com



Hobbico Mini Digital Tachometer

Hobbico's Mini Digital Tachometer provides accurate readings of dynamic and peak rpm. The results are displayed on an easy-to-view backlit LCD screen. Simply aim the tach at the prop to assist in optimizing your power system. Compact in size, the Mini Digital Tachometer takes up very little space in your field box. It works on 2- to 9-blade propellers and measures up to 99,999rpm on a backlit LCD screen, and it includes a CR2032 Li-Ion battery.

\$29.99 | hobbico.com



Harry Higley Heavy Hubs

Machined from dense brass material, Harry Higley Heavy Hub and Ultra Heavy Hub prop nuts have a smooth and polished appearance. They simplify using electric starters by giving the starter a large gripping surface. They're intended for use with .20- to 1.20-size engines. The 2-ounce Heavy Hub and the 4-ounce Ultra Heavy Hub help balance tail-heavy airplanes.

\$9.95-\$19.95 | harryhigley.com



Ram RC Strip LED Nav Lites

The latest editions to the Ram RC product line are two sets of LED strip lighting. Priced at \$24.95, the RAM 198 set of stick-on lighting is 36 inches long, with more than 60 high-intensity LEDs that are wired for a 2-cell LiPo pack—no soldering required; the 1/4-inch-wide strip easily sticks to any model surface. The RAM 199 set, priced at \$29.95, is 72 inches long and includes more than 100 LEDs wired for a 3-cell LiPo pack. Both sets come with red, green, and white LEDs and are wired with a connector that mates to the LiPo battery pack's balance plug. There's no switch required. (Battery packs not included.)

\$24.95; \$29.95 | ramrcandramtrack.com



RC Fueling Systems Gasoline Container

With several sizes and types available, the RC Fueling Systems' 5-gallon gasoline fuel system comes complete and ready to use. Designed with safety and reliability in mind, it features a main power switch with a battery charge jack, an "On-Off-On" toggle switch for fueling and defueling, an internal pickup equipped with clunk filter tube, and a 90-day replacement warranty on all parts. The container includes a 12V 2450mAh NiMH battery pack, which is easy to charge and to check voltage through its JR-style charge jack. All the electrics have plugs and receptacles for easy replacement, and plug-and-play replacement parts are available. An optional feature is available in the form of a pump speed control, which lets you dial in the fuel flow you want depending on the size fuel line your airplane is plumbed with. Priced at \$139.95 (standard) and \$169.95 (with speed control), RC Fueling Systems has containers for gasoline, kerosene, and smoke oil in 2- and 1-gallon sizes, with manual and electric pumps.

\$139.95-\$169.95 | rcfuelingsystems.com

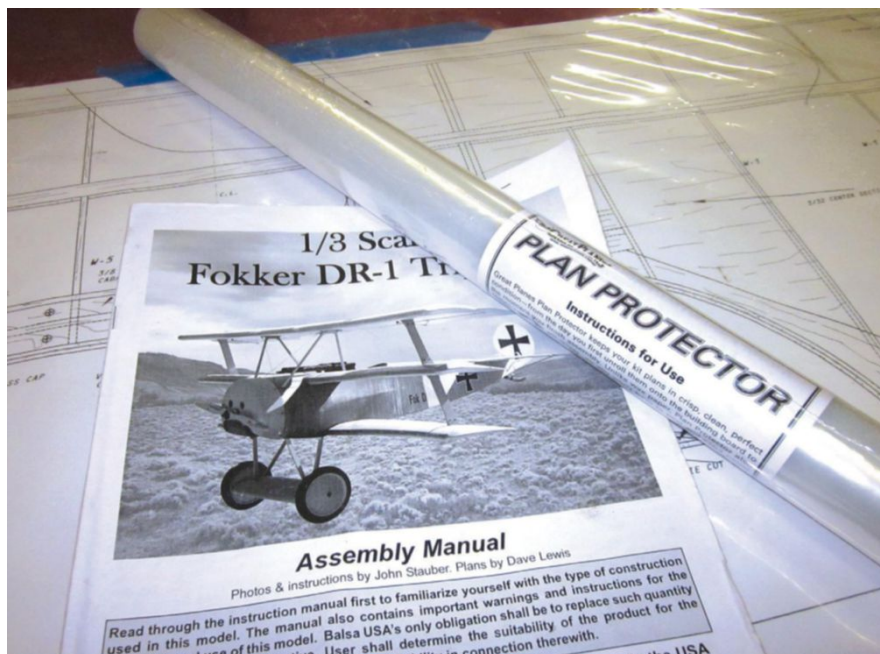


Hitec RCD S60 Camera

This rugged professional-grade action camera is designed to capture 16MP

still photos and HD 1080p/60fps video. It comes with a waterproof case and a detachable 2-inch LCD back screen for viewing your footage. It's Wi-Fi-enabled, and can be controlled with your mobile device using a downloadable app.

\$299.99 (camera); \$469.99 (S60 full package) | hitecrcd.com



Great Planes Plan Protector

Available on a 25-foot roll, this clear plastic Plan Protector material keeps your model plans in crisp, clean condition. Plan Protector resists modeling adhesives and makes removing your parts from the workbench easy. No more peeling and sanding paper scraps away from your glue joints.

\$8.99 | towerhobbies.com



Great Planes After Run Engine Oil

Provided in a 2-ounce, long-nose bottle, Great Planes After Run Engine Oil is ideal for all two- and four-stroke glow engines. Use it after the last flight of the day to protect bearings and internal parts from corrosion and to help prevent gum and varnish buildup.

\$3.49 | towerhobbies.com



Actuatorix RC Linear Actuators

The Actuatorix L12-R, L16-R, and PQ12-R series of linear servos operate as direct replacements for any standard analog rotary servo and use standard three-wire (ground, power, and signal) connector leads. There are 21 models of RC linear servos for use in any RC project. Designed to work with typical RC receivers and battery packs, they are also compatible with Arduino control boards, VEX Microcontrollers, and many other similar control boards designed for robotics. The L12-R series is the standard range of micro linear servos, and they come in three stroke lengths (30mm, 50mm, and 100mm) and three gearing options, for moving forces between 2 and 17 pounds. Priced at \$70.00, the L12-R actuators are ideal for moving scale canopies, doors, large drag flaps and spoilers, or other scale functions where a standard servo setup can't provide the required power and stroke length.

\$70.00 | actuatorix.com



Great Planes Precision Prop Reamers

Available in various sizes (and metric and standard SAE), these stepped T-handle propeller reamers are a must-have for your workbench. Reamers accurately size the holes in propellers, so they will precisely fit your engine. They also make balancing your props more accurate.

\$10.99-\$14.99 | greatplanes.com

ProTek R/C Universal Radio Case

This case has a tough aluminum shell with reinforced corners, locking latches, and a high-density foam lined interior. A foam insert is not included but is available to fit RC airplane transmitters. The case will accommodate Airtronics, Spektrum, JR, and Futaba transmitters. The interior dimensions are 14 x 10 x 5.5 inches.

\$49.99 (case); \$17.99 (Pick & Pluck foam insert) | amain.com



Red Baron Storage Bags

Stay organized with these high-quality carry bags specifically designed for RC equipment. Red Baron Hobbies has several bags for different-size wings as well as these ultra-handly battery and propeller bags. Made with a vinyl-backed polyester exterior with a 1/4-inch foam-lined tricot lining, these bags protect your gear at the field and in the shop.

\$67.30 (battery); \$37.30 (propellers) | redbaronhobbies.com

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Master Airscrew Razor Plane

Made out of tough filled-composite plastic, the Master Airscrew Razor Plane is for all serious builders of wood airplane kits. It is adjustable, removes material quickly, and comes with extra single-edged razor blades. Replacement blades are also available.
\$8.60 | masterairscrew.com



Precision Aero Glue Caddy Kit

This light-ply, laser-cut kit assembles in minutes and helps organize your workbench. It holds three sizes of glue (0.5, 1, and 2 ounces) as well as round epoxy bottles. Store your epoxy right side up or upside down so that it's always ready to use. There is also a place to keep your pencils, pens, or hobby knives.

\$12.95 | precision-aero.com



Ram RC Wireless Nav Lites

Ram's new micro wireless flashing LED Nav Lites come packaged with three dime-sized red, green, and white modules, which weigh a total of 5 grams. Powered by a replaceable button battery, there's no wiring or soldering required. They can be easily attached to any model that weighs 1 ounce or more.

\$14.95 | ramrcandramtrack.com

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Sullivan SkySmoke Smoke Fluid

Teaming up with Super-Dri, Sullivan Products has come out with its new SkySmoke Smoke Fluid. Made with 100 percent paraffinic oil, SkySmoke contains no zinc chloride, so it burns much cleaner and produces thick billowy smoke. Intended for RC use, it's compatible with all RC airplane materials including foam, paint, iron-on films like MonoKote, and fabrics such as SolarTex. With a street price of \$29.99 (1 gallon), it works great with Sullivan's SkyWriter Smoke Pump System and is also great for turbine jet engines.

\$29.99 | sullivanproducts.com



MaxAmps 1S/1Si Parallel Charging Adapter

Charge up to three 1S LiPo packs at once! These parallel charging adapters are specifically designed for MaxAmps' 1S 400mAh packs for the popular Heli-Max 1SQ, 1SQ V-Cam, and 1Si series of quadcopters.

\$11.99 | maxamps.com

Sullivan ProFlex Fuel Line

We all hate that moment when the noisy thing pulling our airplane through the sky goes silent! With time, the alcohol in today's gasoline makes a typical gas-compatible fuel line swell to the point that the internal pickup line within the fuel tank simply falls off. No fuel pickup means the engine signs off for the rest of the flight. Enter Sullivan Products! Made out of proprietary fluoroelastomer, a ProFlex fuel line will never harden or swell. Impervious to gasoline, glow fuel, diesel, and smoke oil, ProFlex is also heat resistant, so it is great for big-block gas engines and smoke mufflers. The thin-walled fuel line is very flexible and won't kink, even in tight bends. It is available in standard and large diameters and in three lengths: 6 inches (\$3.67-\$4.89), 2 feet (\$7.59-\$8.69), and 12 feet (\$27.99-\$29.99). Standard clunk tie wires are included in the replumbing kits.

\$3.67-\$29.99 | sullivanproducts.com



SharpRC ArmSafe

Equipped with 12AWG wire, the SharpRC ArmSafe kit is a great way to add safety and convenience to your electric RC airplane. All hardware and arming plugs are included. Simply remove the Deans connector to make it impossible for your plane to start accidentally.

\$13.40 | sharprc.com



Hammond Workstation

Simple to assemble at the field, this workstation breaks down into a relatively small package for transport, taking just a couple of minutes and four cotter pins to get this thing up and together. Adjustable for different heights, the top cradle can rotate 360 degrees, and the arms open to accommodate different-length fuselages. The midsection tray is perfect for holding bolts and hardware, along with batteries and other model accessories. A nice workstation for the pits and at home, the Hammond Workstation makes assembly, repairs, or just normal airplane maintenance convenient. Priced at \$79.95 (plus \$25.00 for shipping), it's a good investment.

\$79.95 | rcworkstation.com



SIG Field Boss Flight Box

The laser-cut Field Boss Flight Box kit is designed specifically for modelers that want everything at their fingertips. Measuring 11 inches deep, 16 1/2 inches tall, and 24 3/4 inches wide, it has three large drawers, a huge top center workspace, and four compartments for gel-cell or wet-acid-type batteries and plastic bottles or metal fuel cans. Ample space is provided for your 12-volt starters, props, and other field equipment.

\$77.99 | sigmfg.com

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RADIO: MLP6DSM with Spektrum™ DSMX® technology

MOTOR: 180 Brushless (installed)

BATTERY: 280mAh 2S 7.4V LiPo battery (included)

CHARGER: DC charger with AC adapter (included)



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Robart Z-Poxy and Fiberglass Starter Kit

Having little odor, Z-Poxy Finishing Resin is a lightweight, two-part epoxy, intended for laminating and finishing model airplanes. Whether you are fiberglassing the center section of a wing or the entire airplane, Z-Poxy is easy to mix and use. Ideal for sealing all engine and fuel-tank areas, it is great for sheeting foam wing panels. It will bond to itself and doesn't get brittle with age. The Z-Poxy Finishing Resin (#PT-41, 4 oz.) is perfect to use with the new Fiberkit Fiberglassing Kit. If you have never finished an RC airplane with fiberglass cloth, the Fiberkit is a great way to start. The new fiberglassing kit contains all you need to get started including a brush, a spreading card, sanding sticks, six mixing sticks, and five mixing cups. You need to supply your own fiberglass cloth, but Robart has a great how-to video on its website to guide you, step by step.

\$9.95 (kit); \$11.69 (resin) | robart.com



Harry Higley LeRoy's Easy Hinger

These slot cutters make installing your hinges perfectly aligned a piece of cake. Specifically designed for instant CA glue hinges, these tools are made out of aluminum and use common no. 11 hobby blades. Packed in pairs, the small hinger uses a single blade, while the larger one holds two blades for a wider slot.

\$16.69 | harryhigley.com



Sullivan Marcy's Marvelous Wheel Chocks

Made out of anodized aluminum, these chocks are designed for maximum safety and security for your plane during transport. They conserve space in trailers and vans, enhance storage efficiency, and can be used on the workbench during hardware and radio installation.

\$21.95 | sullivanproducts.com



RTL Fasteners

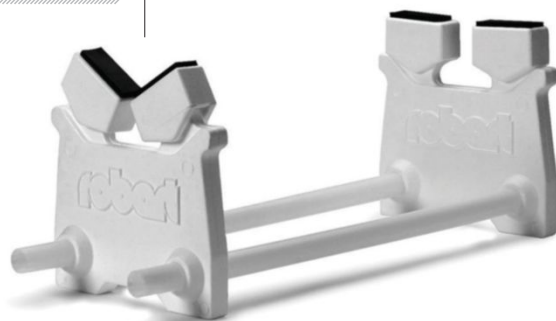
Perfect for RC pilots and hobbyists, RTL Fasteners offers bulk packaging for all commonly used and specialty hardware. Metric and standard SAE sizes are available in small 10- to 100-count bags as well as in handy assortment packaging. From standard servo screws and nylon wing hold-down bolts to socket-head screws, brass inserts, and stainless steel hardware, RTL Fasteners has it all.

\$3.63 (2-56 x 3/8-in. Socket Head Cap Screw, 24 pcs.); \$98.95 (#1450 Standard Assortment, 1,228 pcs.) | rtlfasteners.com

Sullivan SkyWriter Smoke Pump

Electronically controlled, the SkyWriter Smoke Pump is an onboard smoke system that is easy to set up and use. You can set the smoke fluid flow rate with your transmitter. It works with 6- to 12-volt battery packs.

\$94.99 | sullivanproducts.com



Robart Super Stand II

Fast to set up for any building, maintenance, or transportation needs, the Super Stand II is fully adjustable to fit any-size RC airplane. Sturdy, lightweight, and unaffected by glow fuel, the stand is equipped with soft rubber pads to prevent damage to your model airplane.

\$26.45 | robart.com

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Sullivan Starter Box

Made out of tough molded plastic, this cordless Starter Box easily attaches to the Sullivan Hi-Tork and Dynatron starters and can be adapted to fit most other starters. The microprocessor-controlled LEDs display battery-charge levels and are compatible with LiPo, LiFePO4, NiMH, Ni-Cd, and lead-acid battery packs. It includes attachment brackets, hardware, and a 60-amp fuse.

\$52.99 | sullivanproducts.com



X-Acto Basic Knife Set

The Compression Basic Knife Set offers X-Acto's most popular hobby knives and blades used by serious modelers and hobbyists. Three X-Acto knives are included with a full set of precision knife blades. Housed in a soft nylon compression case, the set includes an instruction guide and a reference booklet.

\$25.99 | xacto.com



Xuron RC Model Aviation Tool Kit

Ideal for field repairs or workbench tasks, this kit includes the Model 2175 Maxi-Shear Flush Cutter, for soft wire and materials up to 12 AWG; the Model 2193 Hard Wire Cutter, for hard wire up to 1mm in diameter; and the Model 501 Adjustable Wire Stripper, with a thumb-adjustable cam that can accommodate wires from 10 to 26 AWG. Packaged in a handy canvas pouch, all the tools have a blackened finish to prevent glare and have cushioned rubber hand grips and a light-touch return spring.

\$55.40 | xuron.com



Wing Tote Wing Bags

Designed for RC planes with two separate wing panels, the Double Totes (available in several sizes) include a center layer 3/8-inch foam enclosed in fleece to separate the two wing panels and use Velcro to secure it to the bottom. On the front is a long joiner tube pocket that's large enough to easily insert and remove the tube. A pocket to hold a spare prop is also included.

\$99.99 | wingtote.myshopify.com



Zap-O Foam Safe CA Glue and Kicker

If you're building molded-foam airplanes and need parts to be glued together, look for the purple Zap label. With the same gap-filling properties as Zap-A-Gap CA+, the medium-thick Zap-O formula cures in roughly 15 seconds and is an odorless CA. To cure properly, Zap-O Foam Safe CA must be used with Zap Foam Safe Kicker. It also works great on balsa, plywood, basswood, and most other modeling and hobby materials. The glue and kicker combo works great on EPS foam, cell foam, carbon fiber, foamboard, polystyrene plastic, balsa, and plywood. Give Zap-O Foam Safe CA Glue (PT-25, 0.7 oz.) and the Zap Foam Safe Kicker (PT-28, 2.0 oz.) a try. They are also great items to keep in your field box for quick-and-easy field repairs.

\$5.95 (kicker); \$10.07 (glue) | franktiano.com

TrakPower TK950 Soldering Station

This heavy-duty 60-watt design heats quickly to temperature and has a range of 392°F to 896°F. It holds temperature settings to within 1.8°F when idle. The station includes a soldering iron with stand, a sponge, a temperature control unit, chisel-point and pencil tips, and an instruction manual.

\$79.99 | towerhobbies.com



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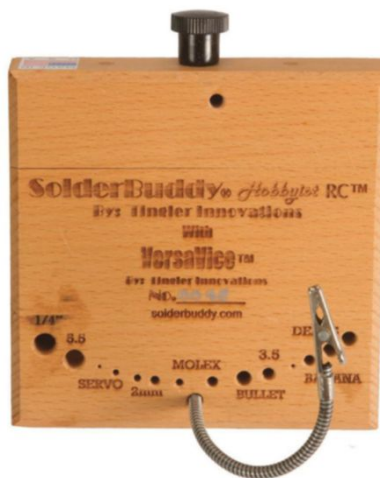
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Zap Silicone Tape

Available by the roll (1 inch x 10 feet) in black, red, and white, this silicone tape leaves no sticky residue, is waterproof and airtight, and seals wet or dry. Simply stretch and touch the tape back onto itself and it makes a permanent bond. Because it's fuel resistant and unstretched off the roll, it is easy to use for fuel-tank installations and can insulate electrical wires up to 8,000 volts.

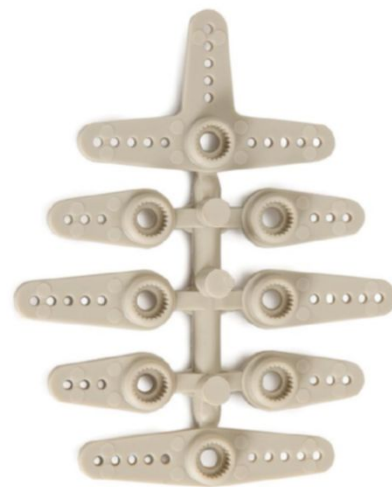
\$5.95 | zapglue.com



Tindler Innovations SolderBuddy

This handy soldering aid holds all of the most popular connectors used by RC hobbyists. It can secure several connector types, including Deans, 3.5mm bullet, Molex, 2mm, servo, and 5.5mm power connectors, while providing a convenient and stable platform for soldering your connectors. Several types of SolderBuddy holding fixtures are available.

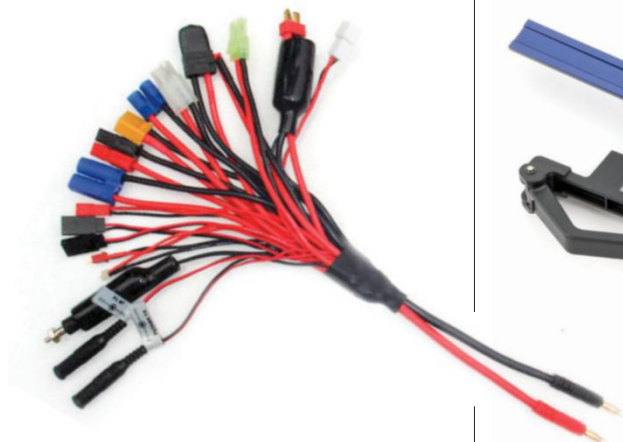
\$46.95 | solderbuddy.com



Du-Bro Super Strength Servo Arms

Available in sizes to fit all major brands of standard servos, Super Strength Servo Arms are made out of long carbon-fiber composite for added strength. Packaged in eight-count bags, they are available for Futaba, Hitec, JR, Airtronics, Tower Hobbies, Hobbico, and Command servos.

\$10.42-\$13.13 | shop.dubro.com



ProgressiveRC Multi-Connector

Constructed out of high-quality materials, this multiple connector lead includes 18 of the most popular connector types, all wired in parallel to one set of banana plugs for attaching to your charger. Heavy-duty 10 AWG silicone wire makes up the main charge lead, while the individual connector leads use various gauges of the same-quality wire.

\$16.99 | progressiverc.com



Horizon Hobby AnglePro II

Replacing the original 4-in-1 AnglePro Digital Meter, the new AnglePro II uses a commonly found CR2032 lithium battery and has an auto power-off feature. The incidence attachment allows precise digital measurement of airplane wing, tail, and thrust angles, and allows for easy calculation and adjustment of control throws. The AnglePro II attaches to most control surfaces and resets to zero at any angle, so there's no need to level the airplane. It also works as a precision level.

\$59.99 | horizonhobby.com

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FMS

Super EZ V2

A terrific ready-to-fly trainer and sport plane for land and sea

TEXT BY JASON BENSON PHOTOS BY JOHN REID



For years, FMS has been making a variety of foam sport models. Its simple and valuable designs have always been a great addition to our hobby. The new Super EZ V2 with optional floats is no exception; it's a great trainer and Sunday flier that boasts wonderful flying characteristics and a straightforward design. The Super EZ is built entirely out of molded high-density foam. ABS pieces are used where necessary, and everything is well thought out.

All you need to complete your Super EZ is included in the box with the exception of your transmitter, receiver, flight battery, and charger. All hardware is divided into bags for easy assembly. There is also an anodized aluminum prebuilt landing gear, with axles and wheels preinstalled. There are also extensions for the servo connections that need them and everything you will need to mount the included floats.

FMS designed this plane for the beginner pilot and beyond. It claims that the Super EZ needs no electronic stabilization to be a good first trainer, and after flying it, I have to agree. The Super EZ is a great-flying plane, and with a little help from someone with experience, anyone could use it to learn to fly.

AT A GLANCE



MODEL

Super EZ V2 PNP



MANUFACTURER

FMS



DISTRIBUTOR

Force RC (forcerc.com)



WINGSPAN

48 in.



PILOT SKILL LEVEL

Beginner to intermediate



ASSEMBLY TIME

15 minutes



RADIO REQ'D

6-channel



POWER REQ'D

3S 1800mAh LiPo



PRICE

\$179.99

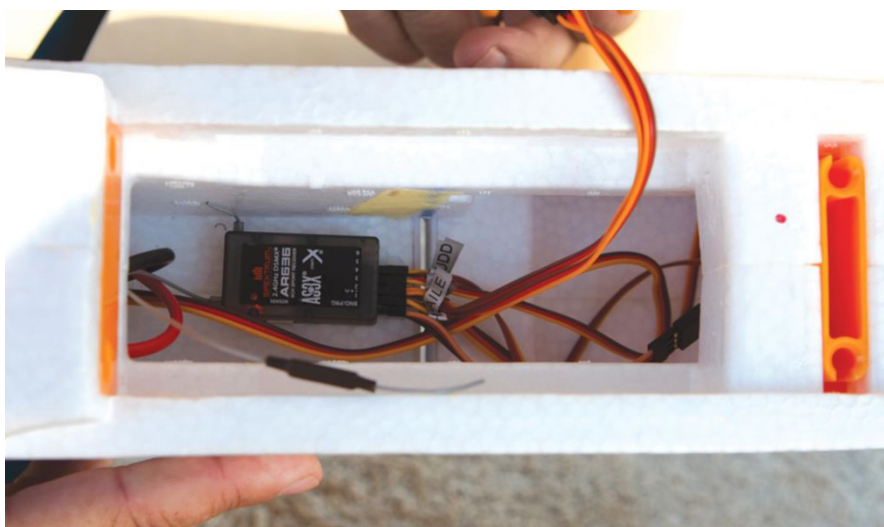
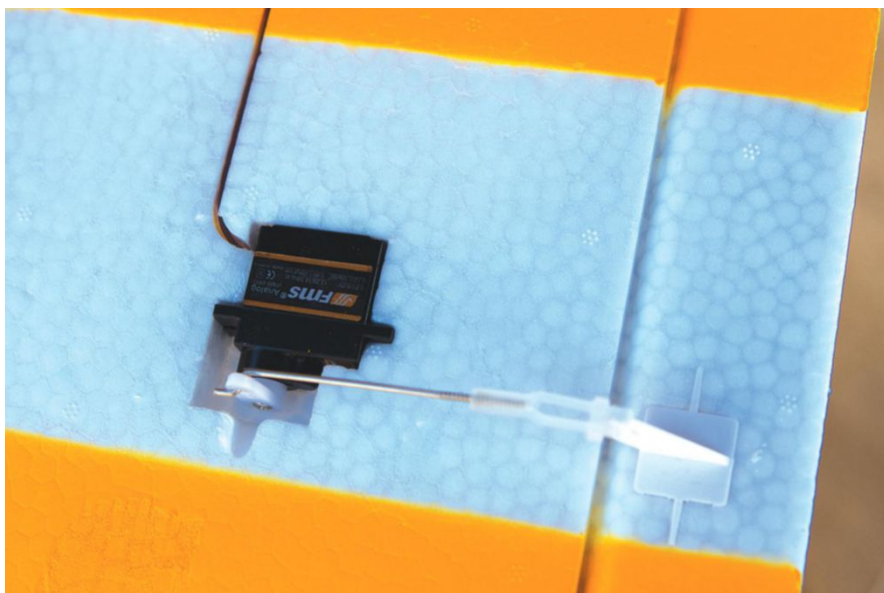
WHAT WE LIKE

- + Quick build time
- + Great flight characteristics
- + Easy to transport
- + Included floats



ALL YOU NEED TO COMPLETE YOUR
SUPER EZ IS INCLUDED IN THE
BOX WITH THE EXCEPTION OF YOUR
TRANSMITTER, RECEIVER, FLIGHT
BATTERY, AND CHARGER.





Top: All servos come preinstalled and ready for flight. **Above:** There is plenty of room for your receiver and all wiring beneath the wing. **Right:** The ABS quick-connect system for the wing is a nice touch and makes installing and removing the wing fast and easy.

GEAR USED



RADIO

Spektrum DX9 w/ AR636 receiver (spektrumrc.com); 9g servos (installed)



MOTOR

3136 1230Kv brushless motor and 20-amp speed control (installed)



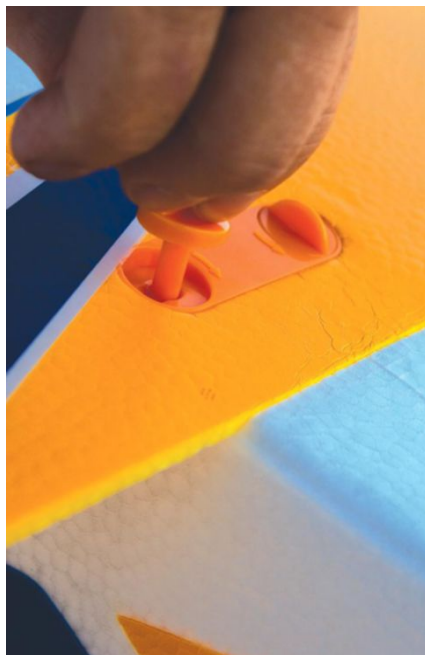
PROP

10x5 (included)



BATTERY

Thunder Power 3S 1800mAh Lightning Series (thunderpowerrc.com)



UNIQUE FEATURES

All the control surfaces on the Super EZ are prehung and ready for flight. Even the pushrods are preinstalled with the exception of the elevator, which you connect after you install the horizontal stabilizer on the fuselage. The Super EZ uses the standard “full house” controls: throttle, elevator, rudder, and ailerons. The lack of flaps and retracts simplifies the assembly process and minimizes the number of things you, as a modeler, need to be concerned with.

As mentioned earlier, everything on the Super EZ is constructed out of foam. The only exceptions are the few ABS items, like the spinner, the wing hold-down, and the control horns. Everything comes preattached and ready for final assembly, and no glue is required—a nice touch. Everything is attached with metric screws, which speeds things up and avoids any potential mess. Most of the screws are Allen-head types.

Another nice feature is the included quick-release “screws,” which allow you to remove the wing in a matter of seconds. FMS even tapered them to match the airfoil of the wing for a clean look. When building the Super EZ, I made zero modifications to the intended design. The motor, prop, and spinner on the Super EZ even come installed. The speed control is prewired, and the motor turns in the correct direction. Molded-in ducting keeps everything nice and cool.

The Super EZ also comes with all graphics applied, using both paint and decals. There is no finish work left for you, other than to assemble the model and fly.

IN THE AIR

The wheels on the Super EZ are a little on the small size. For this reason, you will want a well-manicured grass runway or something smoother, like packed dirt or pavement. The Super EZ is small and slows down nicely, so you really only need about a 200-foot runway. This or a decent-size pond without a lot of trees is all you need for good flying fun.

GENERAL FLIGHT PERFORMANCE

Stability: The Super EZ is extremely stable. FMS designed this plane to fly without electronic assistance, and it did a great job. From slow to fast, I always felt in control and comfortable. I even spent a good portion of my flight flying low and slow without ever leaving the perimeter of the runway and without exceeding 10 feet. The Super EZ handled it all with ease.

Tracking: As a high-wing model, the Super EZ will get buffeted around a little with a breeze or thermal activity, but overall, it goes where it is pointed.

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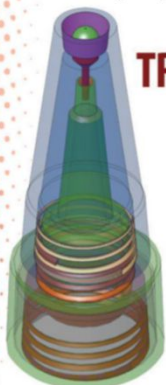
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This 73-page bookazine is a collection of articles
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understanding of drones, from the basics of the
aircraft to gear and gadgets, mastering flight, and
troubleshooting tips.

From the editors of **MODEL
Airplane
NEWS**

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Floating Around

In addition to fixed gear, the FMS Super EZ comes with optional floats. After a couple of flights with the conventional landing gear, I switched to the floats to see how they went on and performed on the water.

The swap out is about as simple as it gets. The landing gear comes off with three screws, and the float struts go on with the same three on the front and four more on the rear. The included cross-braces and strut connection points are all secured with setscrews, and everything went together perfectly. The final step is to plug in the included Y-harness and route one of the leads through the floor in the precut slot and connect the water-rudder servo wire. Then you are ready to head to the lake.

On the water, the Super EZ handled great. There is plenty of rudder authority to stay away from obstacles, which is not always the case with float planes. You may want to add a little bit of expo to the rudder for water operation because the ample rudder authority can make takeoff a little erratic if you aren't gentle with the rudder. Once in the air, the Super EZ still has plenty of power to pull around the extra weight and drag of the floats.

Be aware that the water rudder on the Super EZ is fixed. This means that if you hit something in the water it will not swing out of the way to protect itself. You also need to be careful with it during transport. This is not a huge deal—just something to keep in the back of your mind when handling the Super EZ on floats.



Aerobatics: Although this is not an aerobatic model, the Super EZ does a great job on all the basics. It has plenty of power for big round loops and performs rolls, hammerheads, and Cuban-8s.

Glide and stall performance: With its light wing loading and fairly clean lines, the Super EZ glides well and has an almost unnoticeable break in a stall. When the power was pulled back, I found it easy to retain my airspeed and

glide all the way to the runway for an easy touchdown.

PILOT DEBRIEFING

The Super EZ really delivered on all of FMS's promises. It is a lot of fun to fly and would definitely make a great trainer or Sunday fun model.

BOTTOM LINE

The Super EZ can easily be built in an evening; I think my total build time was about 15 minutes. The exclusion of a need for glue helped keep assembly time to a minimum. Building and flying the Super EZ was about as easy as it comes. ✚

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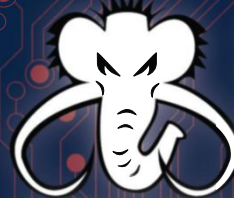
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250



Thrust 250 Newtons 25.49 Kg 56.20 Lbs
Idle thrust 8 Newtons 0.82 Kg 1.80 Lbs
RPM range 28,000 RPM to 108,000 RPM
Weight 2.28 Kg 5.02 Lbs
Diameter 124.10 mm 4.89 inch
Length 325.40 mm 12.81 inch
Exhaust Gas Temp. 500° - 700°
Fuel consumption 688.5 g/min 0.81 Lts/min 28.51 Oz/min



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Tower Hobbies Uproar V2 .46/EP ARF

An updated version of a sport favorite

BY MICHAEL YORK PHOTOS BY JENNY & MICHAEL YORK



Those of us who have been in this hobby for a while can certainly remember the original Uproar 40 kit. It was easy to build, and its all-around flight capabilities made it an instant favorite. It took a while, but version 2 is finally here. Gary Wright's original design has been updated for even better performance, and time-challenged pilots will appreciate that it's now an almost-ready-to-fly (ARF) model.

The model comes fully covered, and just like the original, it is built with an open balsa/light-ply structure. It's designed for either a .46-size glow engine or equivalent electric power such as a RimFire .32, and it has hardware for both, including engine mounts and fuel tank. Speaking of hardware, the plane comes complete with everything you need besides radio gear and the powerplant. All items are neatly packaged in baggies and grouped together as needed for the assembly, which really helps keep bolts and screws from getting lost or mixed up. An excellent manual guides you through the assembly and offers a lot of construction tips and hints.

The Uproar V2 is an excellent choice for intermediate pilots or advanced beginners as well as expert pilots who want a go-to plane that can do everything their hearts' desire.



AT A GLANCE



MODEL

Uproar V2 .46/EP ARF



MANUFACTURER

Tower Hobbies
(towerhobbies.com)



WINGSPAN

47.6 in.



PILOT SKILL LEVEL

Intermediate



ASSEMBLY TIME

8 hours



RADIO REQ'D

4- to 5-channel



POWER REQ'D

.46 glow or equivalent electric

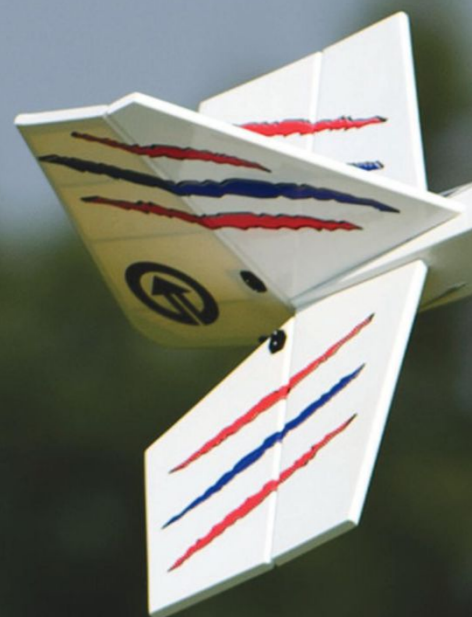


PRICE

\$99.99

WHAT WE LIKE

- + Quick assembly
- + Very light airframe
- + Extremely wide flight envelope
- + Low price of admission



THIS PLANE CAN COVER A WIDE GAMUT OF FLYING AND WILL BE THE ONE YOU GRAB WHEN YOU CAN TAKE ONLY ONE BIRD TO THE FIELD. JUST LIKE THE ORIGINAL, THE TOWER HOBBIES UPROAR V2 CAN BE BUILT AND FLOWN BY NEARLY ANYONE AND WILL CERTAINLY BECOME A CLASSIC IN ITS OWN RIGHT.



Pilot's View

If you are not ready to fly your plane fully FPV, consider using an action camera to see what the view is like from your model while you fly. The Strix Goblin that we reviewed this month has the perfect place for a Mobius action camera to be mounted on the canopy/hatch.

Before you fly, hit record and then go have fun. The views are breathtaking, and watching the footage of a high-speed pass is



Don't let all the decals intimidate you. They are easy to work with and feature some of the best placement instructions I've ever seen. In this shot, you also get a nice view of the thick airfoil.

almost like being in the pilot's seat of a high-speed jet.

If you are like me, you will find yourself wanting to make the move to full FPV flying to experience the view all the time. It is also a great way to get people interested in what we do. When you show them what our planes are capable of from the perspective of the "pilot," it drives home what a great hobby we are involved in.

So if you have a compact action camera and an airframe with a place to mount it, as with the Strix Goblin, you have no excuse not to get some footage of future flights. You may be surprised at the views you capture!



Top: It doesn't take much to have an exciting day at the field. This is an affordable package, and with a radio like the new Futaba T6K, you can still program the Uproar V2 to your heart's content. **Above:** There is ample room for a large 4S battery, and the simple layout makes quick swaps easy. If you go glow, this hatch allows for an easy tank installation.

GEAR USED



RADIO

Futaba T6K transmitter (futaba rc.com), four Tactic TSX20 servos (tacticrc.com)



MOTOR

ElectriFly RimFire .32 brushless outrunner (electrifly.com), Phoenix Edge Lite 75 speed control (castle creations.com)



PROP

APC 13x8E (apcprop.com)



BATTERY

FlightPower 4S 4350mAh 30C LiPo (flightpowerbatteries.com)

UNIQUE FEATURES

When I first picked up the box, I was wondering if Tower Hobbies accidentally sent me an empty carton. This thing is light! It's basically a high-lift wing with a minimalistic fuselage and tail. I knew it was going to be a fun plane to fly.

Assembly is typical for a wooden ARF. There is just enough work to be done to make you feel like you've accomplished something. There is minimal prep of the covering material prior to the assembly, and a quick once-over with a covering iron or heat gun will ensure everything is taut. A few spots of the covering need to be removed, like servo openings and wing-joint areas, and it's a good idea to save the removed covering pieces for spot repairs in the future. Hinges for all the control surfaces need to be glued in place, but they come preslotted.

The tail feathers feature tongue-and-slot alignment, which makes it easy to ensure that the assembly is true. Don't go crazy with the epoxy, as any extra unnecessary weight will need to be compensated for at the front end to achieve balance.

The two-piece wing (an update from the original one-piece wing) plugs onto a 3/4-inch aluminum tube and is held in place with a simple tab/bolt setup, making transport and storage a breeze (although with a 47-inch wingspan, the Uproar is easy to transport fully assembled). One of the differences from the original design is the removable side-force generators. Since the fuselage has a very low profile, the side-force generators allow the Uproar V2 to easily perform knife-edge flight as well as provide additional directional stability.

I decided to go electric, but as I mentioned, everything is included to go glow as well. Either way, it is easy to install the powerplant, thanks to a simple fuselage layout.

Radio installation couldn't be easier, thanks to the removable hatches and preinstalled servo trays, which are a perfect match for the recommended Tactic TSX20 servos. The pushrod housings are in place, and the included control clevises feature a threaded pin that allows you to remove any free play.

The simple landing gear is plenty long to allow for larger props, and a template makes sure that you correctly drill the mounting holes.

A large decal sheet is included, and since the model is a plain white canvas, it lends itself to personalization. The finishing touch is a large crystal-clear canopy, which you trim and glue in place with clear plastic adhesive.

IN THE AIR

With the recommended motor and battery, the Uproar V2 balanced just a tad tail-heavy from the midpoint, which the manual recommended. The Uproar does have a wide center-of-gravity range, but I always like to test-fly at the suggested point. Despite adding just a bit of lead, the model came in right at the manufacturer's recommended weight.

With all that wing and plenty of power, the model was airborne in just a few feet. Control throws on low rates were very relaxing, and once I got a feel of the handling, I switched to mid- and 3D modes. As you can imagine, with those large surfaces, the Uproar's characteristics go from mild to wild.

Landings are a pleasure, and a bit of power allows a nice pitch-up attitude for a slow three-point touchdown. The long gear works great both on pavement and in less-than-freshly-mowed grass.

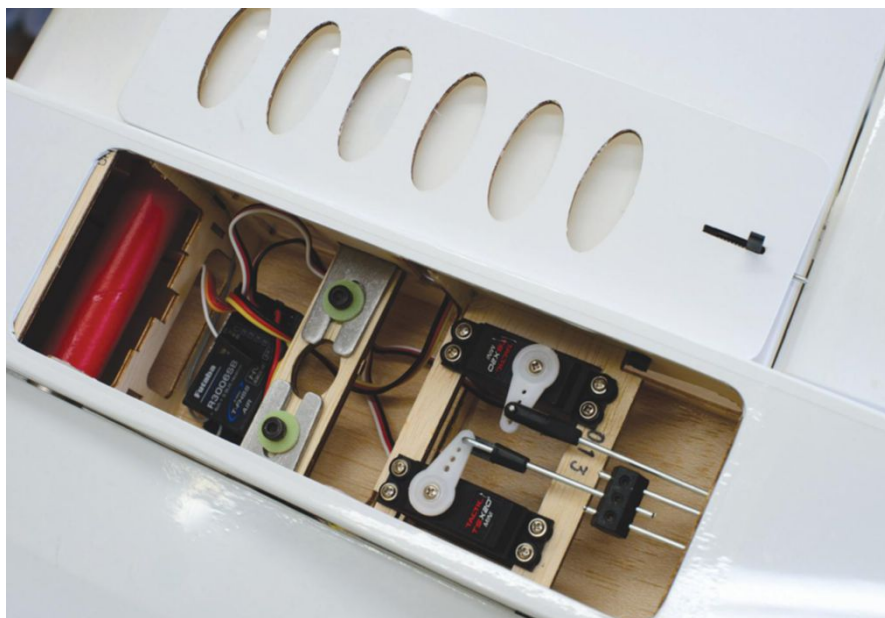
GENERAL FLIGHT PERFORMANCE

Stability: At the recommended center of gravity and low throws, the Uproar V2 can be a docile plane. It isn't quite a trainer, but it is very predictable.

Tracking: With its flat wing, the Uproar V2 is a point-and-go type of plane. The side-force generators do keep things pointed in the right direction, especially when the center of gravity is in the forward range.

Aerobatics: Move the center of gravity rearward and go to high-throw settings to unleash an aerobatic machine. Though not quite a full-blown 3D plane, it will do pretty much anything you can think of.

Glide and stall performance: This is a clean airframe, and it has a surprising amount of glide when kept flat. Point the nose up without power and the light airframe quickly runs out of momentum. When it does stall, it's straightforward and quick.



Above: With the underside hatch removed, you can see the simple radio installation as well as the ingenious wing retention system. The fiberglass washers ensure that the wings stay put without marring the alloy tangs. **Below:** The Uproar V2 flies just as well inverted as it does right side up. Despite being a simple livery, it was easy for me to differentiate between top and bottom.



PILOT DEBRIEFING

This is a true all-in-one plane. Whether it's slow flying around the pattern or performing physics-defying maneuvers, the Uproar V2 is eager and willing. The addition of side-force generators increases its knife-edge capabilities

as well as its recovery from extreme unusual attitudes. The Uproar V2 is a confidence-inspiring plane that begs you to try out new maneuvers because it is so predictable in its recovery.

BOTTOM LINE

It took me about eight hours of leisurely building to go from box to flight-ready, but I tend to be a slow builder. This plane can cover a wide gamut of flying and will be the one you grab when you can take only one bird to the field. Just like the original, the Tower Hobbies Uproar V2 can be built and flown by nearly anyone and will certainly become a classic in its own right. ±

Lance Campbell's Amazing Lockheed SR-71 Blackbird

**The story behind this RC
project that took nine years
to complete**

BY THE *MODEL AIRPLANE NEWS* CREW

PHOTOS BY LANCE CAMPBELL, RICH URAVITCH, DAVID HART & BARRY VAUGHT

At the 2017 Top Gun Scale Invitational, there were many amazing aircraft flown by some of the best pilots in the world. One of the standouts on this year's flightline was an unusual aircraft in the form of a Lockheed SR-71 "Blackbird" that was totally scratch-built by first-time Top Gun competitor Lance Campbell of Columbia, Missouri. Lance did an amazing job and earned second place in the Expert class. The Blackbird scored an impressive 99.167 static points, and at the Top Gun awards banquet, Lance also received the Engineering Excellence award, sponsored by Robart Mfg., as well as the Critic's Choice award, sponsored by Zap Glue and *Model Airplane News*. Using Futaba radio gear, Lance flew the SR-71 to a total flight score of 195.709 points. The 85-pound SR-71 is 13 feet long and is powered by a pair of JetCat 140-RXi turbines.

After the competition, we had a chance to catch up with Lance to get the inside story on his amazing award-winning and super-smooth-flying Blackbird.





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Posing on the Top Gun runway, Lance Campbell, with his Lockheed SR-71, shows off his impressive awards.

Model Airplane News: Why did you choose the SR-71 for a project?

Lance Campbell: To be honest, the moment I decided to do it, I wasn't expecting it. Quite a while ago, I was really interested in doing a Zivoli B-25. I planned a trip to the Wright-Patterson Air Force Museum [National Museum of the United States Air Force] in Dayton, Ohio, to gather documentation photos to start the project. When I toured the museum, I first saw the SR-71 in person. As I looked at the SR-71, I was just struck with the notion that this was too cool of an aircraft *not* to do—and to try to do it justice as accurately as possible. There was also an appeal to try to do something unique. Even today, you can count on one hand the people that have done a scratch-built SR-71 and made it to the flying field with it.

How did you develop your plans?

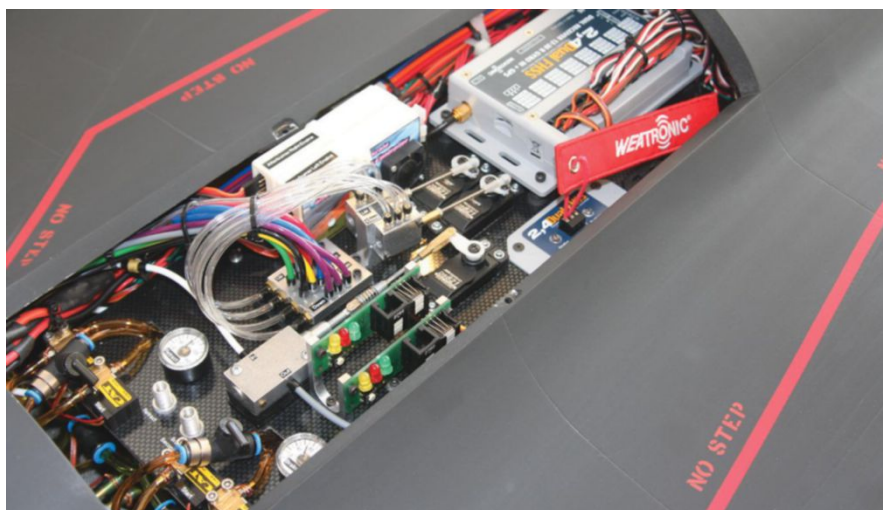
I started with a rough set of plans but soon realized that much of it was incorrect. I retained around 10 percent of them. As I dug deeper for reference materials, I made a few initial contacts with people involved with the real program. I developed a positive cycle in that, as the project progressed, some in the full-size community saw my sincere effort and started to provide materials to help the project along. Then I'd publish further progress on my build blog, and follow-on materials would show up. By this time, I had visited about six of the planes in various museums and taken several thousand photos as well.

This might be hard to believe, but the plane was built with no plans. I had a rough outline and core dimensions, but ultimately I needed to carve nearly the entire thing to shape. Using composite plugs and molds meant that the first shape being made was a fully solid object that needed to perfectly match the shape. Internal formers and equipment placement would come later and was not relevant at this stage. That's not to say that I didn't scrutinize every dimension and angle dozens of times to cross-reference them against Lockheed schematics and all the photos. When the shape was as correct as I could possibly make it, I used lasers to assist in laying out the hundreds of panel lines and corrugations. This way, I could properly place panel lines across compound curves.

With the plugs done, I cast fiberglass molds over every part. This was my first time trying any of this. Prior to this project, I had never done any significant fiberglass work and never made a mold at all, but I was always curious to learn. When the prototype was laid up in the molds, I could then start making the traditional model formers to carry the model's components and provide the needed structure. I couldn't do this until this late state because I had to take into account the thickness of the skin of the airplane. So, in some ways, it was like making the plane from the outside and progressing inward.



Talk about scale! The pilot and RSO (Range Safety Officer) are wearing the proper David Clark space suits. The front instrument panel is detailed with every knob, switch, and gauge.



With the hatch removed, you see just some of the equipment onboard the twin-turbine-powered Blackbird.



This photo shows the hot end of the Blackbird, with its double-wall thrust tube and the LED ring that simulates afterburner function.



Here's one of the distinctive inlet spikes. It's angled slightly down and inward, just like the full-size Blackbird.

How long did it take to produce your prototype?

Initially, I thought this was [going to be] a four-year project. Boy was that wrong! It took three years to make the plugs (doing the panel lines and corrugations was a year of that time). Then

I spent two more years to make the molds. Then another two years to make the first prototype, including all the internal former design work and development. So it was seven years before the prototype flew.

Speaking of the prototype, I designed it from

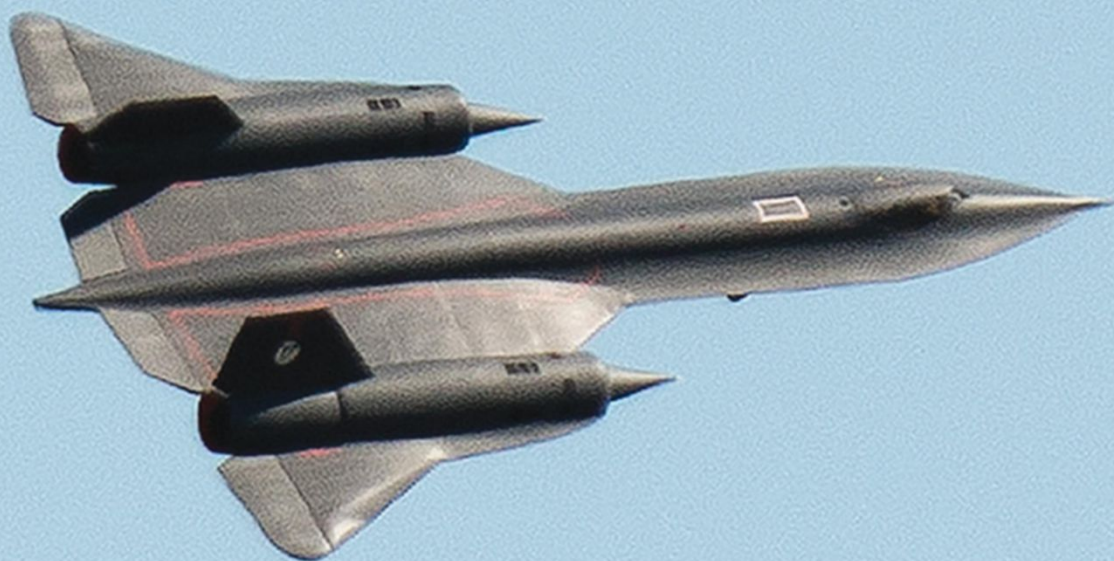


This photo, taken during the static judging, shows just how big Lance's aircraft really is.

***"I THOUGHT THIS WAS [GOING TO BE] A FOUR-YEAR PROJECT. BOY WAS THAT WRONG!
IT WAS SEVEN YEARS BEFORE THE PROTOTYPE FLEW."***

From this angle, it is impossible to tell the model from the real thing.





"IT REALLY TRACKS AND FLIES LIKE IT'S ON RAILS. LIKE THE FULL SIZE, IT'S BUILT FOR ONE THING: TO GO FAST IN A STRAIGHT LINE. THE MODEL DOES THAT BEAUTIFULLY."



On takeoff, the ring of LEDs shows up well, simulating an afterburner departure.



And just like the full-size Blackbird, Lance's SR-71 uses a 42-line ribbon drag chute to shorten the landing rollout.



"I USED THE EXCUSE OF NEEDING LANDING GEAR TO PURCHASE A MILLING MACHINE AND A LATHE AND TEACH MYSELF ABOUT METAL WORKING. I SPENT ABOUT A YEAR MAKING THE LANDING GEAR."

Lance also scratch-designed and built his own scale landing gear. All six main wheels have their own independent disc brakes.

the beginning to be flown in private and to be a test mule. I spent an entire summer flying it (using model-airplane engines and propellers) and slowly adding one system at a time, getting the bugs worked out. It was never going to be painted, and I could hack holes in it where I needed to try different things as part of the test-flight program. Armed with those results, I spent the next two and a half years to use the existing tooling to finish the show plane and start flying it in public.

What was involved to design and build the landing gear, and how long did it take?

Along with mold making, I was also interested in machine work. I used the excuse of needing landing gear to purchase a milling machine and a lathe and teach myself about metal working. It is great fun and not too bad to learn. During the last two and a half years of building the show plane, I spent about a year making the landing gear. The wheels and brakes were developed by Glennis Aircraft, and the retract mechanisms are Tom Cook's Mk 30 units, which work great.

The biggest development part was starting with the correct spring that would give me the proper travel and compression strength and then designing the strut and gear around it. That way, it would sit properly on the ground, rotate correctly, and touch down properly on landing.

What materials did you use in the layout of your parts?

Since this whole process was new to me, I made the prototype stronger than it really needed to be. I laid it up with two layers of 6-ounce S fiberglass cloth, with 6-ounce carbon cloth in areas of high stress. For the show plane, I lightened that to two layers of 4-ounce S fiberglass cloth and 6-ounce carbon cloth in areas of high stress. That change alone lightened the show plane by 12 pounds from the prototype's weight. I also made plugs and

molds for the four integrated fuel tanks and laid those up with Kevlar cloth.

For the show plane, knowing the black plane would get quite hot in the summer sun, I did the layup with a high-temp resin from Resin Services, which also supplies some of the resins used by some NASCAR racing teams. The resin I used is solid to 325°F and does not require a post cure. It just cures at room temperature, but it does take a couple of days to get to its full hardness.

What are the SR-71's flight characteristics like?

It flies great. After so many years on a project, you set a pretty high bar on how well you hope it flies. Even with those high expectations, it flies even better than I could have imagined. It really tracks and flies like it's on rails. Like the full size, it's not an aerobatic plane, and it's built for one thing: to go fast in a straight line. The model does that beautifully. Like the full size, it does not turn in a short corner, either. It takes about a thousand feet to do a 180-degree turn with the model when at flight speed, but then again, the full-size bird would take two states to turn around in, so it's all relative.

For slower flight and in the landing circuit, it's really predictable and well behaved. The real bird has some very complex things going on in the outer wing panels, which have a very unique droop in them. This helps with an equivalent of washout that we are familiar with in our models. I was so worried about getting these outer wings correct in this droop, so I made them as separate plugs/molds. If the plane did not behave correctly in flight, I could redo these outer wings to address it. Turns out, I got the droop spot-on, and the plane has all the good characteristics you want: predictable low speed and high speed that tracks dead-on straight, without a click of trim's difference between them.

Do you have any comments on being successful with a project that takes years to complete?

Something like this really just takes as long as it takes. It is a hobby after all, and the build process should be fun in its own right, without pressure to get it done and to be at the field with it before it's finished. To stay motivated, I really focused on just the next stage of the build and did not dwell too much on being done with it, as that part sorts itself out eventually. I hope that others see a project like this and are encouraged to tackle their own planes that they would like to do, even if they are a bit off the beaten path.

For more photos and information go to ModelAirplaneNews.com/SR71. ✈



Ready Made RC Strix Goblin

**Perfect for long-range cruising
or high-speed FPV**

BY JASON BENSON PHOTOS BY JOHN REID



Designed for high-speed runs of more than 100mph or long-range, high-efficiency cruising around 50mph, the Goblin sports a blow-molded orange ABS fuselage that is aerodynamic and rugged. Its wings are constructed of high-density EPO foam with carbon-fiber spars for rigidity. There is no covering to mention as all parts sport a natural finish and color is added with the included decal set.

This plug-and-play model comes with its power system and servos installed and ready for flight.

The only hardware to mention are the four screws that are used to attach the wings to the fuselage. The plug-in wings are supported by an extremely strong and well-designed square carbon-fiber spar. There is also a clever wing center section that has an optional light-ply tray, which can be used for your receiver or first-person-view (FPV) gear.

The Strix Goblin is intended for the intermediate-and-above pilot. It is extremely fast and nimble, so you will want to have some experience with higher-performance models. You also need to hand-launch the Goblin as there is no landing gear, so be prepared for that.

AT A GLANCE



MODEL

Goblin



MANUFACTURER

Strix



DISTRIBUTOR

Ready Made RC
(readymaderc.com)



TYPE

FPV plank



WINGSPAN

39 in.



ASSEMBLY TIME

Less than an hour



PILOT SKILL LEVEL

Intermediate



POWER REQ'D

4S 3300mAh LiPo



PRICE

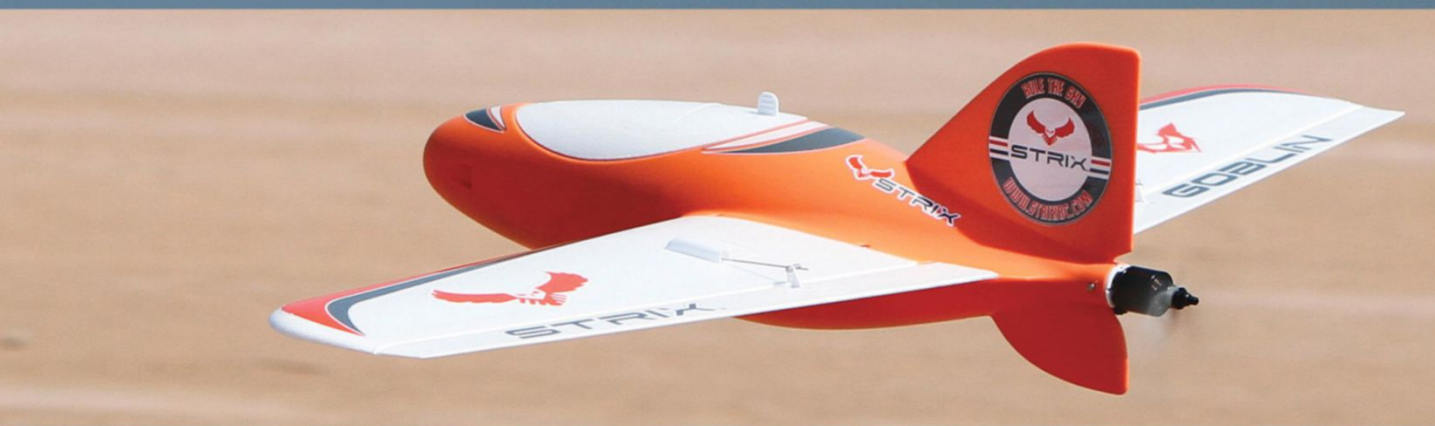
\$249.99

WHAT WE LIKE

- + High-speed, straight-and-level flight
- + Plenty of room for all your gear
- + Easy to assembly
- + Durable



BUILDING THE GOBLIN IS QUICK: THE BASIC ASSEMBLY TAKES LESS THAN AN HOUR. DEPENDING ON YOUR FPV SETUP, YOU SHOULD BE ABLE TO COMPLETE THE ASSEMBLY IN AN EVENING. EVERYTHING IS WELL DESIGNED, MAKING THE BUILD OF THE GOBLIN EXTREMELY EASY.



Pilot's View

If you are not ready to fly your plane fully FPV, consider using an action camera to see what the view is like from your model while you fly. The Strix Goblin that we reviewed this month has the perfect place for a Mobius action camera to be mounted on the canopy/hatch.

Before you fly, hit record and then go have fun. The views are breathtaking, and watching the footage of a high-speed pass is almost like being in the pilot's seat of a high-speed jet.

If you are like me, you will find yourself wanting to make the move to full FPV flying to experience the view all the time. It is also a great way to get people interested in what we do. When you show them what our planes are capable of from the perspective of the "pilot," it drives home what a great hobby we are involved in.

So if you have a compact action camera and an airframe with a place to mount it, as with the Strix Goblin, you have no excuse not to get some footage of future flights. You may be surprised at the views you capture!



Mounting the FPV camera in the nose makes for an aerodynamic setup.



Servos come premounted with linkages and covers in place.

UNIQUE FEATURES

The only control surfaces on the Goblin are the elevons on the wings. They arrive prehinged and reinforced with clear tape for sustained high-speed flight and longevity. As mentioned, there is no landing gear on this model, which really speeds up assembly and makes transportation easy.

All parts are preformed and ready for final assembly and flight. No cutting or gluing is required. Strix did a great job designing the Goblin to move quickly from the box to the airfield. The included decals are precut to shape and sticky-backed, requiring no application fluid. The decals added a nice finish to the model, and they laid down nicely.

The four screws used to attach the wings are metric thread with Allen heads. I really appreciate the Allen-head screws, which limit slipping and stripping if you decide to transport your Goblin with the wings off. Another nice feature is the high-density EPO canopy/hatch. It arrived premounted with a quick-release, quarter-turn mechanism in place. It also has a removable insert section that interlocks and is held in place with a rare-earth magnet. When removed, the insert section leaves a nice flat spot to mount your action camera to capture high-definition video of your flight. There are also provisions in the canopy for a pan/tilt FPV camera so that you can look around while you are exploring.

When assembling the Goblin, I made no modifications. Strix really did its homework and provided plenty of opportunity for flexibility for



The rear-mounted motor is in the open, making access straightforward.

the modeler regarding equipment used. The included Cobra 2217 2300Kv outrunner came premounted in the tail for the plane, and it is out in the open, making access to the motor a nonissue. I like the fact the Strix turned to Cobra

GEAR USED



RADIO

Spektrum DX9 and AR636 receiver (spektrumrc.com); 9g digital metal-gear servos installed



MOTOR

Cobra 2217 2300Kv outrunner and 60A speed control (installed)



BATTERY

Thunder Power Adrenaline 70C 4S 3300mAh (thunderpowerrc.com)



PROP

APC 6x4E (apcprop.com)

for the motor/speed control combination. With the FPV camera, I chose not to use a pan/tilt setup and instead used a body reamer to open a hole in the nose of the fuselage. I opened up the hole to the perfect size to thread my camera lens in. I then used the locknut for the lens to secure it to the fuselage. After a little testing, I found that the camera had to be loosened about half a turn to focus the picture. To keep the camera from getting loose and backing out, I went to the local hardware store and found an appropriately sized O-ring to act as resistance to keep things in place.

IN THE AIR

The Goblin is a model that must be thrown for takeoff and belly-landed. For this reason, a grass field is best suited for operation. We flew our Goblin off my club's packed-dirt runway, and there was no issue. Just make sure you have plenty of room for your approach and landing.

GENERAL FLIGHT PERFORMANCE

Stability: The stability of the Goblin surprised me. With its relatively small size, it seems heavy when you get the battery in and ready for flight. Once in the air, the Goblin flies lightly and is controllable at all speeds.

Tracking: When we performed our initial flights on the Goblin, one of the onlookers likened it to more of a guided missile than a plane. It tracks straight as an arrow and doesn't seem to hunt for a line at all—just point it where you want it to go and hold on.

Aerobatics: The Goblin has no rudder and small elevons. It is not designed for aerobatics. I did perform a few loops and rolls, and it did them with no issues. I did notice that the ailerons could use some differential to straighten the rolls, and I will work on this during future trips to the field.

Glide and stall performance: Strix says that it considered efficiency and aerodynamics during every step of designing the Goblin, and it shows. The model carries its airspeed extremely well and will glide for what seems like forever. As with stability, the stall performance of the Goblin blew me away. Before bringing it in for landing, I did a stall test at altitude and found that I could apply up-elevator until I was holding it all the way back and the Goblin would slow to walking pace and continue to fly straight ahead. The Goblin never dropped a wing or tried to spin. On landing, I used this trait to slow down and land the plane close enough that I didn't have to walk a hundred yards to retrieve the model.

PILOT DEBRIEFING

The Strix Goblin delivers everything that is promised in its advertising: blisteringly fast, straight-and-level flight; high efficiency for cruising; quick assembly; and durability. I am excited to get to know this model better. If you are interested in an FPV plank, check out this model.



Mounting the camera in the nose leaves plenty of room for your battery and electronics.



The optional light-ply tray is a great place to mount your receiver or FPV transmitter.



The included grip tape helps you keep your grip during launch.

BOTTOM LINE

Building the Goblin is quick: The basic assembly takes less than an hour. Depending on your FPV setup, you should be able to complete the assembly in an evening. Everything is so well designed, making the build of the Goblin extremely easy. Make sure to research your options for FPV gear, and try to place anything that generates heat directly behind the molded-in air ducts. There is plenty of room to lay out your gear in a clean and orderly fashion. ±

THREE IMPRESSIVE TURNAROUND MANEUVERS

Add some style to your routine

TEXT BY JOHN GLEZELLIS ILLUSTRATIONS BY FX MODELS

For many, watching a precise aerobatic routine is almost like watching an aerial ballet, and to the aerobatic pilot, there is no feeling that is more gratifying than executing the perfect flight. Flying flawlessly boils down to having not only a properly tuned aircraft but also a firm understanding of your own ability as well as what's required for each individual maneuver. Mastering the various maneuvers is the first part, but there's still another important element needed to develop a successful sequence. By using turnaround maneuvers, you can stitch your moves together so that the entire flight presentation is smooth and flowing. Choosing the right turnaround maneuver also helps you set up and plan the order of your flight segments. Here are three advanced turnaround maneuvers that will add excitement to your overall aerobatic routine.



HALF CUBAN-8

EXIT the maneuver at the same altitude and heading but in the opposite direction as the entry.

ENTER straight and level, straight into the wind.

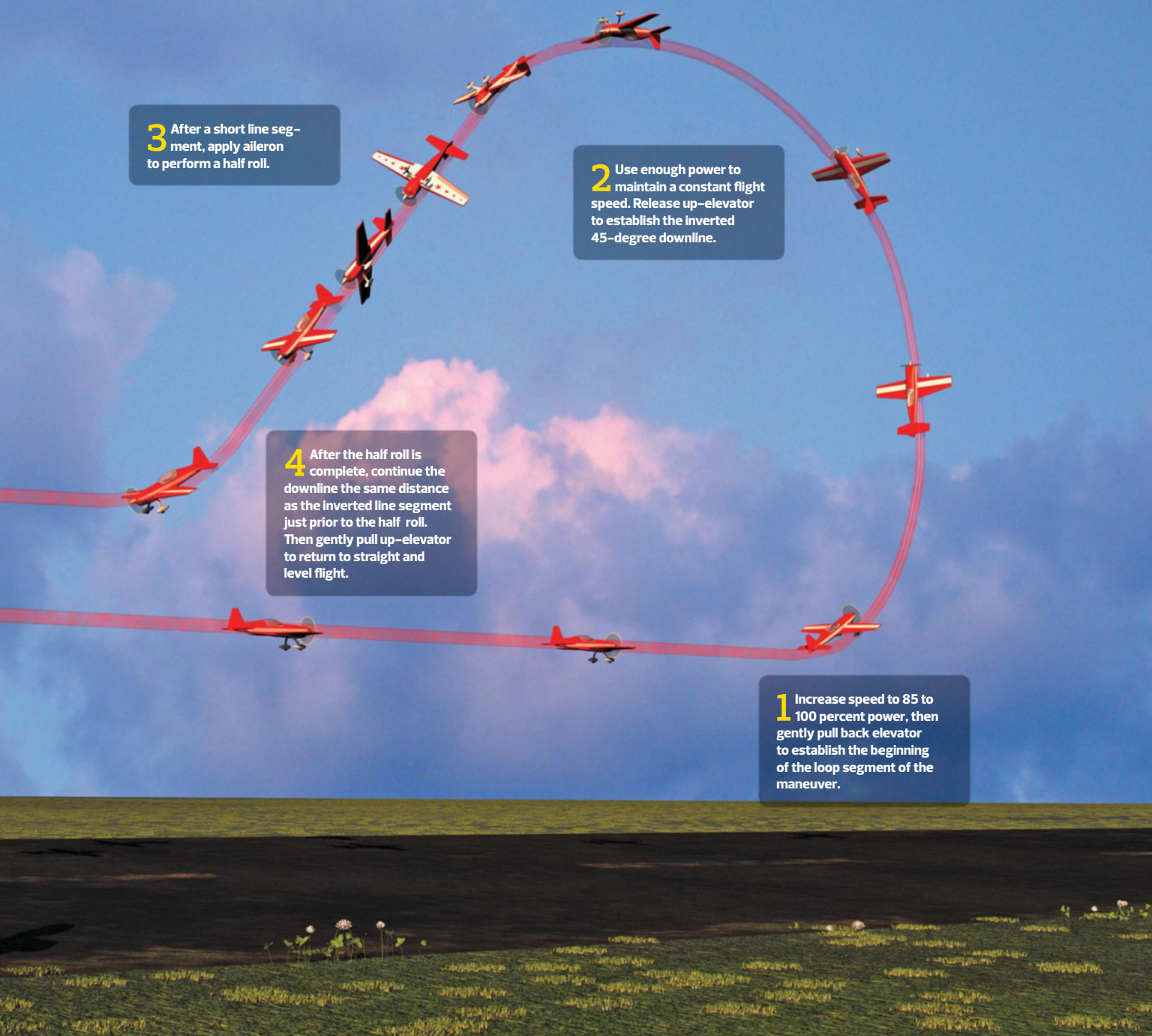


HALF CUBAN-8

Invented in the 1930s, the half Cuban-8 was first flown by American barnstormer Len Povey. While attempting a triple avalanche, his entry speed was too high, so he decided to abort the attempt with a simple half-roll on the back side of the figure. Thus, the now-common maneuver was born! Today, the half Cuban-8 is popular with the full-scale Red Bull Air Race and is used as a standard turnaround maneuver.

OVERVIEW

For the first few attempts, start at a generous altitude for additional safety. The traditional half Cuban-8 begins from upright level flight parallel with the runway. Pull 5/8 of a loop to establish an inverted 45-degree downline with a brief line segment as shown in the illustration. Perform a half-roll, and add a second line segment (equal to the first). Finally, pull the model into a 1/8 loop segment, exiting the maneuver at the same



3 After a short line segment, apply aileron to perform a half roll.

2 Use enough power to maintain a constant flight speed. Release up-elevator to establish the inverted 45-degree downline.

4 After the half roll is complete, continue the downline the same distance as the inverted line segment just prior to the half roll. Then gently pull up-elevator to return to straight and level flight.

1 Increase speed to 85 to 100 percent power, then gently pull back elevator to establish the beginning of the loop segment of the maneuver.

altitude as the entry and traveling in the opposite direction.

BY THE NUMBERS

Step 1: Increase throttle to about 85 to 100% power. Establish the maneuver by gently pulling elevator. The amount of elevator used affects the overall size of the inside-loop portion. Using a small amount of up-elevator results in a larger figure, whereas using more elevator deflection will make the loop smaller.

Step 2: As the model nears the top of the loop segment, start decreasing throttle to maintain a constant flight speed. Once the inverted 45-degree downline is established, stop pulling elevator. Define the 45-degree downline by performing a brief line segment, and take note of the line segment's length.

Step 3: Next, perform a half-roll by applying aileron. Once the half-roll has been completed, fly a second line segment that's equal

to the first line's length. Apply corrective inputs as needed to keep the aircraft in the desired orientation.

Step 4: Finally, perform a smooth 1/8 inside loop to establish an upright-level exit. It is important to note that the entry and exit altitude should be the same.

VARIATIONS

Like all aerobatic figures, maneuver variations are seemingly endless. Instead of

performing a simple half-roll, you can execute a full roll and then push a 1/8 outside-loop segment and exit inverted. Rather than a continuous half-roll, you could also perform hesitation rolls (two points of a four-point roll, four points of an eight-point roll, etc.). Use your imagination. As with all maneuvers, the traditional half Cuban-8 requires a certain amount of time to master. It takes practice to perfect proper techniques.

TAILSLIDE

While it may seem simple, the traditional tailslide is one of the most challenging maneuvers to perform properly. At all times, you must apply precise control inputs and maintain a certain orientation to ensure that the aircraft falls backward. Orientation of the model can often become difficult, and the smallest heading deviation can result in an unsuccessful attempt. Also, you have to remember that, in a proper tailslide, the control inputs are opposite compared to when the aircraft is in forward flight! Simply said, there's lots of "think" flying going on in the pilot's head.

This is the "wheels-up" version of this maneuver. Breaking this maneuver down into four basic steps will help explain the various inputs required, so let's get started.

OVERVIEW

Typically, the maneuver is performed either to the left or right side of the aerobatic airspace. For a midsize aerobat, fly the maneuver at the end of the runway so that you have a better visual of the aircraft. For the first few attempts, perform the maneuver about 200 feet away from yourself, into the wind and parallel to the

runway.

Initiate the maneuver by performing a gradual 90-degree pull to establish a vertical upline. After a short line segment for about five seconds, begin decreasing power. As the aircraft nears a complete stop, activate the appropriate flight mode and continue to apply the required corrective control inputs to maintain a vertical attitude. Remember: If the airplane is not completely vertical, it will not slide rearward. Once it is sliding back, apply full down-elevator and the model will fall with the wheels oriented toward the sky. At that point, release the control inputs and return the flight mode to the low-rate setting. A visible "pendulum" may be shown past the vertical as the aircraft falls and establishes the downline, which is completely natural. Apply down-elevator, and exit the figure inverted at the same altitude as you began the maneuver but traveling in the opposite direction!

BY THE NUMBERS

Step 1: Enter the maneuver upright and parallel to the runway, traveling into the wind. Activate the low-rate setting, and apply 75 to 90% power. Gently apply up-elevator, and execute a quarter-loop to establish a vertical upline. Power settings will vary depending on the airplane you are flying. Note the size of the radius.

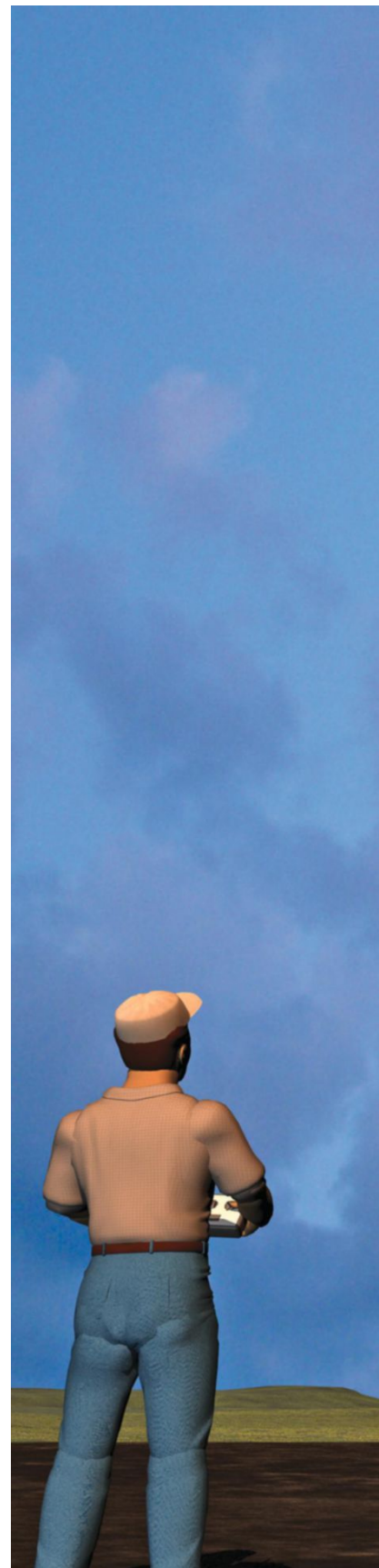
Step 2: When the desired altitude has almost been reached, slowly decrease throttle and apply any corrective control input to keep the proper flight attitude to maintain a perfectly vertical line. As the model begins to slow down, activate your 3D/tailslide rate. I prefer to pull the throttle back so that there's enough power to bring the aircraft to a momentary stationary position, then I pull the throttle to idle.

Step 3: As the airplane begins to fall backward, apply full down-elevator. This will cause the airplane to fall in a wheels-up attitude. During this "pendulum" movement, slowly neutralize elevator and return to your "low-rate" setting.

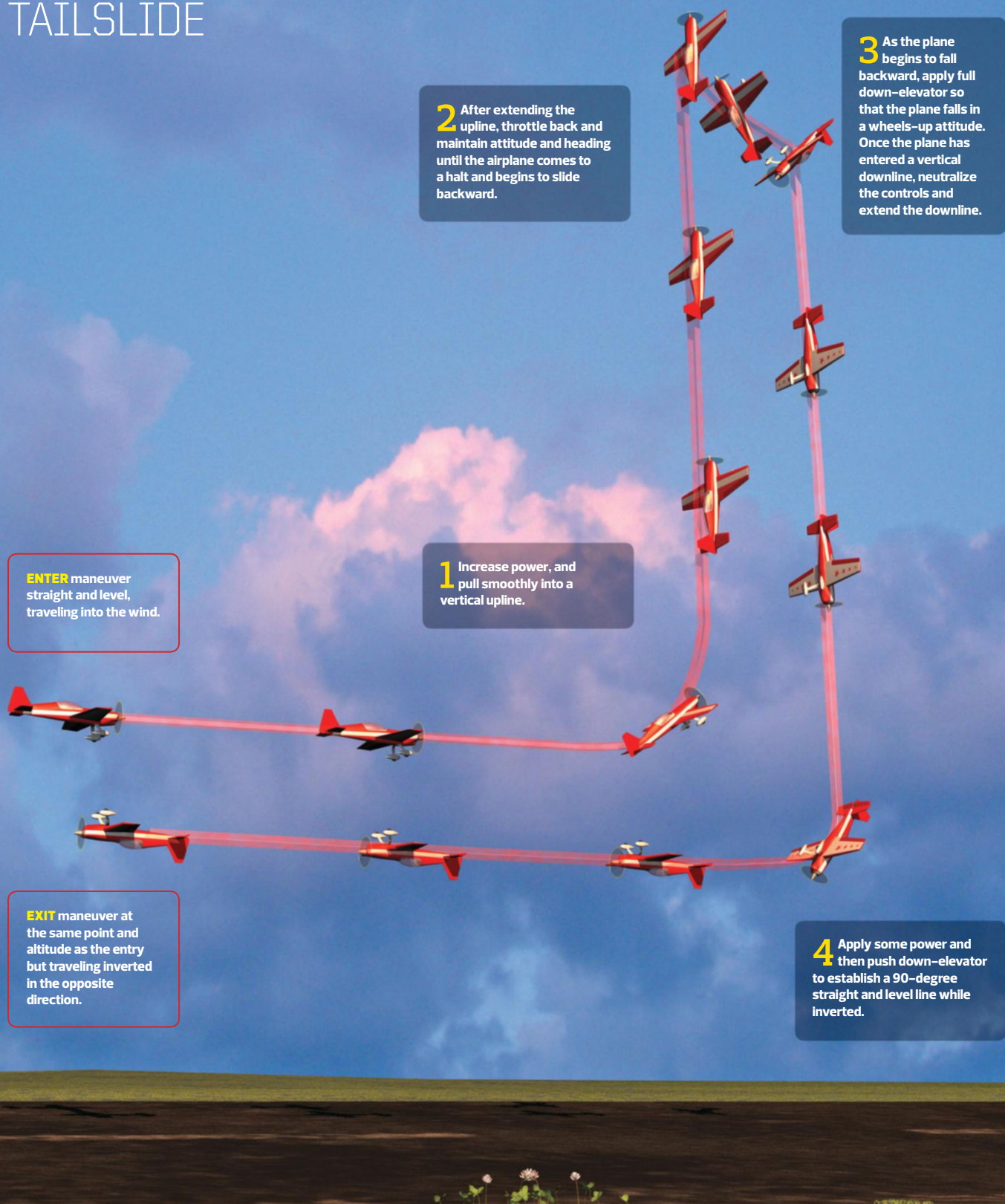
Step 4: Perform a 90-degree push

(down-elevator), and exit the maneuver inverted at the same altitude in which you entered the maneuver. Ensure that the exit

IF YOU FIND THAT YOUR MODEL IS UNABLE TO FALL BACKWARD, EVEN AFTER PROPER ORIENTATION IS ESTABLISHED, IT IS LIKELY THAT THE MODEL IS TOO NOSE-HEAVY.



TAILSLIDE



radius is the same size as the one performed during the entry. To minimize corrections during a flight, you should always

take advantage of the various capabilities of your programmable radio system. Fine-tune your aircraft to suit your personal

preferences, and make changes in small increments until your model responds smoothly to your control inputs. That's it. Now fine-

tune the setup of your plane, and fly the maneuver again! Practice makes perfect.



ENTER in straight and level flight.

FIGURE-6 WITH A HALF-ROLL DOWN

All complex maneuvers are developed from rather simple segment variations. And most successful maneuvers take elements from both the roll and an outside loop. A figure-6 with a half-roll down was maneuver 15 from the 2013–14 precision aerobatics Masters sequence. It works nicely when you want to get turned around while lowering your altitude in an exciting way.

OVERVIEW

During this maneuver, you should orient the aircraft parallel to the runway, flying upright at an altitude of about 400 feet. The altitude will differ depending on the size of the model being flown, but an altitude of 400 feet will suffice for an aircraft that has a 60-inch span. After the heading has been established, the model should perform a 90-degree push (1/4 outside loop) to establish a vertical downline, where a brief line segment will be flown. A half-roll is performed during another line segment, equal in length to the first. The aircraft will then execute a 3/4 outside loop and exit the maneuver in upright level flight in the opposite direction in which it started.

BY THE NUMBERS

Step 1: While the aircraft is traveling at a fairly high altitude into the wind and parallel to the runway, decrease the throttle and gently push to a vertical downline and fly a brief line. To ensure that your lines are equal, it often helps to count “1, 2” during each segment.

Step 2: Next, perform a half-roll at a moderate roll rate and fly another line, equal in length to the first. Again, count “1, 2.” Note that your count will only work if the speed of the aircraft is constant! Make any necessary rudder corrections to keep the flight path of the airplane parallel to the runway.

Step 3: At this point, increase throttle as you begin the push for the 3/4 outside-loop segment. Throttle input will vary depending on the power-to-weight ratio of the aircraft, but it is safe to say that about 75% throttle should be used as soon as the airplane is inverted and passing the 90-degree segment of the 3/4 loop, which is a total of 270 degrees.

Step 4: Once complete, the aircraft must be traveling in upright level flight but in the opposite direction compared to the entry. Throughout the maneuver, various aileron,

elevator, and rudder corrections will be required; apply these inputs as needed to keep the airplane properly positioned.

Pilots may have difficulty with the line segments not being of the same length, loop segments that are not round, or a half-roll that isn't centered on the downward segment. Also, the wind can become a factor. No matter what the wind direction is, the flight path of the model should always be parallel to the runway during the entry and throughout the 3/4 loop, and perpendicular to the runway during the downline segment and half-roll.

THE TAKEAWAY

Don't become frustrated when trying a new maneuver; consistency comes with time and practice. Before taking to the skies, think about the new maneuver in detail and know what control inputs will be required. When you're trying out a new move, it may not look pretty at first, but continue to practice until it looks perfect. And always remember to have fun! ✈

FIGURE-6 WITH A HALF-ROLL DOWN

1 Decrease throttle and push to a vertical downline.

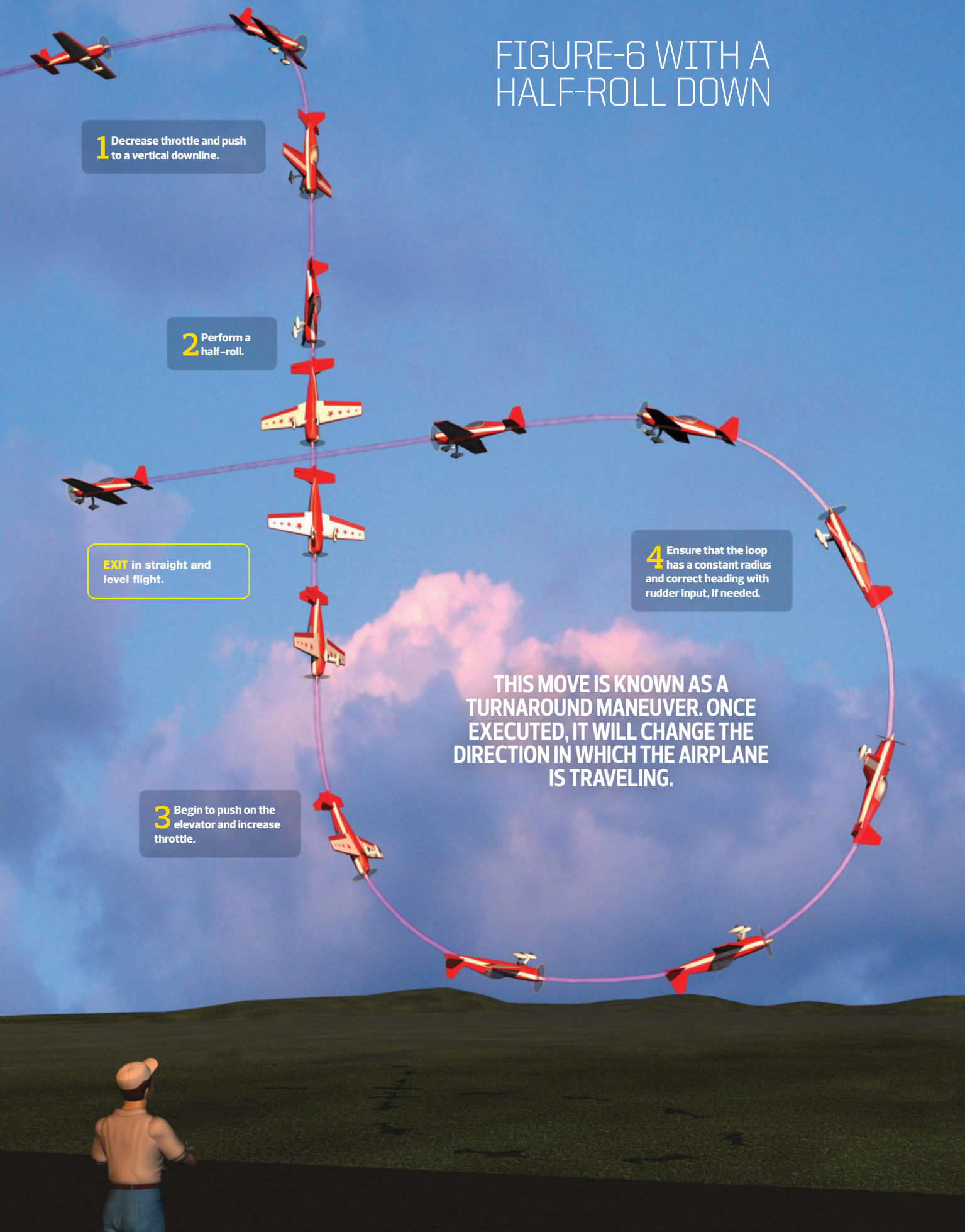
2 Perform a half-roll.

EXIT in straight and level flight.

3 Begin to push on the elevator and increase throttle.

4 Ensure that the loop has a constant radius and correct heading with rudder input, if needed.

THIS MOVE IS KNOWN AS A
TURNAROUND MANEUVER. ONCE
EXECUTED, IT WILL CHANGE THE
DIRECTION IN WHICH THE AIRPLANE
IS TRAVELING.



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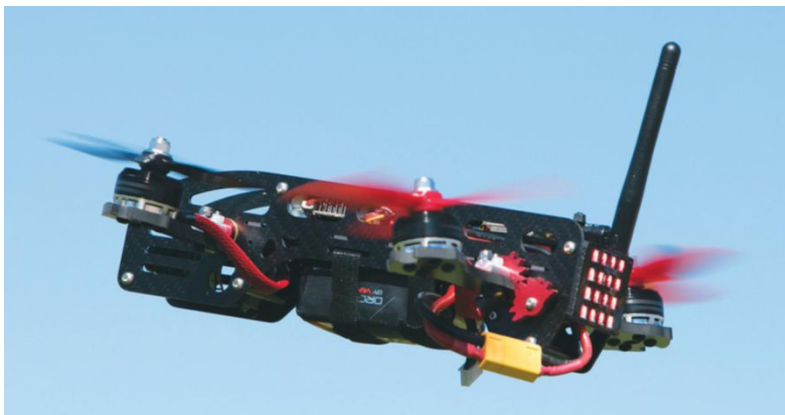
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If you've been bitten by the FPV racing bug, there are literally dozens of racing drones to choose from, including some turnkey packages that lower the cost and difficulty barriers for new race pilots. With so many choices—both well established and brand new—we decided to put together a comparison guide of what's out there for racing. It covers a broad spectrum of price and difficulty levels, from some of our favorite racers to the latest releases. No matter your budget or experience level, you can find the right machine to get you into FPV drone racing, so let's go!

GET THE WINNING EDGE

OUR GUIDE TO THE BEST FPV RACERS

BY THE MODEL AIRPLANE NEWS CREW



AimDroix XRay \$140 to \$500 | Intermediate

The XRay Tilt-rotor platform is built for the racer who wants the fastest forward acceleration with excellent control. We just got this bird in and only had a chance to fly it once, but we have to say that it is fast! The body stays flat, and when looking through the lens, it is like flying a Phantom-size drone on speed—a very smooth experience.

aimdroix.com



Ares Z-Line Crossfire

\$350 | Beginner

In the Ares Crossfire, you have a racing quad that has an attractive price point, comes ready to fly, and only needs a little time for setup. This is the perfect quad for newbie racing pilots who want to get in the air right away and start flying with their buddies on the weekend. This bird not only is fully assembled but also comes with a 3S 2200mAh battery, the preinstalled ultramicro 200mW 40-channel 5-band video transmitter, and 720p high-resolution camera with a 120-degree field of view. The wide angle and quality of the video is right up there with any other racer. With the first couple of flights, you should start out in the stabilizing mode to get the feel of the quad and then turn it down. We found the Crossfire to be a stable flier in all flight modes, and this thing is pretty quick. It is not the fastest one out there, but its speed is competitive with many of the racers flying at events. Depending on how you set up this bird, you'll find that it can be a docile flying machine or a responsive racehorse.

ares-rc.com



Blade/Horizon Hobby Conspiracy 180/220

\$350 to \$380 | Beginner-Intermediate

The Conspiracy has plenty of power to make this a competitive racer, and for an aircraft that comes just about completely assembled, the flight performance is impressive. The Conspiracy really punches out with some power and will move through the course at a competitive speed. The combination of rudder and ailerons will result in tight moves through the corners, and it will hold its line in flat-out straight runs. Adding a sport camera required a little more diligence on throttle and some loss of speed, but the drone had enough power to make it work. The FPV camera angle was easy to adjust and maintained its position throughout the flight, and the rear lights could be seen from some distance. We really liked flying this quad, and all the flight tests were done without having to connect it to the computer to adjust the settings.

bladehelis.com

Blade/Horizon Hobby Mach 25

\$430 | Beginner-Intermediate

This multirotor comes out of the box completely assembled and ready to bind with your radio. The stabilization system on the Mach 25 is very good, and if you are coming from the fixed-wing sector, it is easy to quickly adapt to flying this bird. It wants to get up to speed right away, and we like that. The control is really good in High Bank Angle mode, and you could easily race in that mode. But if you're looking for some quick and snappy flying, then Agility mode would be your cup of tea. Landing was easier because the motor did not have to be canted at an angle, so that is a real plus. Once you adapt to the Mach 25 flying style, you will have a blast scooting around the field. Throw in some obstacles and another racer and you will be totally hooked in the world of FPV racing.

bladehelis.com





Blade/Horizon Hobby Vortex 150 BNF

\$320 | Intermediate

This quad comes ready to race, with a custom power system, cutting-edge ImmersionRC F3 Fusion 32-bit flight control system and full-graphic heads-up display, and a Fat Shark FlightCam with tilt adjustment. There's even a programmable LED system. Everything about this design is geared toward speed. Add your 3S or 4S flight pack and bind it to your radio and we'll see you at the starting line!

bladehelis.com



Connex Falcore

\$799 | Beginner

The Falcore is designed for new racers who might be intimidated by hard-core drone racers that require skill and practice. But that doesn't mean an experienced pilot will not enjoy this up-to-80mph bird. This racer comes with everything you need to get it in the air. The carbon-fiber Falcore is fully assembled with the props installed, and all the expensive and vital equipment (receiver, video transmitter, speed control, and camera) are protected inside the carbon-fiber tube of the body. The Falcore's real advantage, next to its outstanding and uninterrupted ProSight video signal and flight speed, is its simplicity of flight. A switch on the front of the transmitter has three flight modes: Shield, Horizon, and Acro. Shield mode is ideal for anyone who's just getting started in the world of FPV flight. Horizon mode keeps the drone level and cancels out any inputs when the sticks are returned to the home position, and Acro mode leaves it up to the pilot to keep everything level and to control and/or cancel any previous stick inputs.

amimon.com/fpv-market

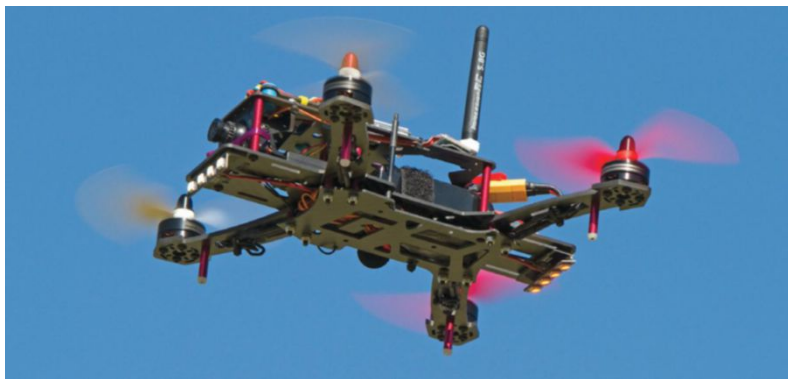


FPV Model Racing #7

\$849 | Intermediate

The #7 is constructed out of beautiful carbon fiber that is held together with lightweight aluminum hardware, which is anodized purple to accent the model. With the almost-ready-to-fly version, all electronics—including BEC, Naze32 FC, 6x4.5 HQ props, SunnySky 2300Kv motors, ESCs, FPV camera, and 5.8GHz video transmitter—come preinstalled and ready for flight. "Assembly" of the #7 is minimal and can be completed in an hour or so. One of the nice touches on this model is the fact that the folks at FPV Model Racing preload the flight controller with clean flight and load the PID settings that work with this model before they ship it out. As such, the #7 feels locked in and really "grooves" right out of the box.

fpvmodelracing.com



Graupner Alpha 250Q FPV ARF/RTF

\$300 (ARF); \$549 (RTF) | Beginner-Intermediate

The Alpha 250Q racer has an innovative combined receiver and flight controller, eliminating excess wiring and weight to create a lightweight, quick aircraft. It comes completely assembled and just needs to be bound to your transmitter—unless you get the ready-to-fly version, which includes a Graupner transmitter. The controls are very responsive, and the 250Q really moves out; if you are flying line-of-sight, it will get out of sight fast.

Having the battery located in the middle of the aircraft allows it to corner well, and the response to the controls is fast. In Attitude mode, the quad levels out when the sticks are released. Switching to Rate mode makes it responsive to the sticks and allows for aerobatics (rolls and flips); this mode requires the pilot to use the opposite stick to get the aircraft to level out. This is the preferred mode for racing because the aircraft will maintain a 45-degree angle.

graupnerusa.com

Hitec QuadRacer 280

\$400 | Beginner

This little drone is designed for the new pilot who wants to get into FPV racing but doesn't want to spend a lot of time on construction. Within minutes, we were in the air with the QuadRacer 280. This is a stable-flying bird out of the box that is easy for any pilot to control. One of the cool safety devices on this bird is a side button on the body that needs to be pushed before startup can happen.

The transmitter is simple to handle; you can easily see the LCD screen, and there are individual switches for stabilization and responsiveness. "High" stabilization mode is perfect for the new pilot, and it does a good job of leveling out the quad when the sticks are released. On "Low," the stabilization is still noticeable but does not interfere as much, and allows a pilot to fly fairly aggressively.

On the other side is the second mode switch, which controls the responsiveness of the quad. In Mild mode, the quad flies smoothly, and there is just enough control to make some fast turns; this is where the new pilot should start out.

Experienced pilots can pull the switch back to "Fast," which allows them to make the turns required for any type of FPV racing; this is the mode that all pilots will eventually move to when they want the best performance from this bird.

hitecrd.com



HobbyKing Black Widow FPV Racer RTF

\$193 | Intermediate

Looking for an out-of-the-box multirotor solution with all the features of a professional system? The team at HobbyKing has come up with the perfect solution. The Black Widow has a beautiful Multistar storage case; the popular TGY-i6 2.4GHz transmitter; a prebuilt, pretuned, and preconfigured quadcopter with CC3D flight controller; 2204-2300Kv motors; a 3S 1300mAh LiPo battery pack; a 6-inch prop set; and a LiPo battery charger.

hobbyking.com



Hitec Vektor 280

\$270 | Beginner-Intermediate

The Vektor 280 utilizes a circuit-board system, and it has all the required power pads and speed controls built into it. Rather than the typical stack of components, you get a slim, compact setup with the aforementioned items and other built-ins, such as programmable LED lighting and DSM and SBus support. If you like doing the PWM thing (one wire per channel), you can because there are wire harnesses for either option. The flight controller is the CC3D Atom and was configured through LibrePilot. Formerly known as OpenPilot, LibrePilot is a free open-source firmware available online. With the 2204 motors preinstalled on top of the arms with wire-loom-wrapped leads fed into the main frame, the Vektor 280 is truly "almost ready to fly." It is also "almost ready to FPV" with a camera preinstalled and prewired to an included 600mW video transmitter. Just add your receiver and display and you're ready to rip.

hitecrd.com



Kyosho Zephyr

\$219 | Beginner

Kyosho's racing drones are specifically designed to lower the difficulty barrier for first-time racers, and one novel way Kyosho does that is by utilizing a pistol-grip radio, easing the transition for RC car racers. This is made possible by the preprogramming of the flight controller with two preset altitudes—35cm and 60cm—so that racers can focus on the other two inputs: steering and throttle. That makes Kyosho's racer the perfect trainer to hone your skills and teach you to fly consistent lines, and the various available speeds are a great way to get you comfortable with flying fast. The available settings and configurations also help you customize the racer to your liking. And with the price of admission at just \$219, the fun you'll have makes it a real steal.

kyoshoamerica.com



Lumenier QAV180

\$75 | Advanced

180-size quads are popular among FPV pilots because they are fast and can turn on a dime. The QAV180 is a textbook airframe for a tight racecourse, so it's perfect for FPV pilots. The first time that you do a flip or roll with this bird, it might surprise you how quickly it performs the maneuver. With the controls turned down, the QAV180 is smooth and enjoyable to fly. This little frame is also tough; it is designed with bumpers around the motors to protect them, and having everything installed inside the frame provides good protection, even against big impacts.

lumenier.com



Lumenier QAV250

\$330 | Intermediate-Advanced

The QAV250 is well known in FPV racing winner's circles—and with good reason. The carbon-fiber construction has just a few parts that bolt together quickly, and on 3 cells, this little quad really moves! The QAV250 is responsive to the sticks even when set to Manual flight mode, but it is still easy to control and fly in Attitude mode, where the controls are fast (needed for racing) but remain smooth.

lumenier.com

Lumenier QAV-XS

\$85 | Advanced

The QAV-XS is a lightweight stretch X designed for high-speed racing action. The airframe is constructed out of nicely finished carbon plates, which are joined together using aluminum standoffs. When you purchase the QAV-XS, you get the bare airframe. You will need to provide all the electronics for flight (flight controller, motors, and speed controls, along with a radio and receiver) as well as the FPV equipment, like the video transmitter and camera.

With the Lumenier MX2206-9 2450Kv motors controlled by Blade Thrust 20-amp Opto speed controls and spinning Lumenier 5x5x3 Butter Cutter props on a Thunder Power 4S 1300mAh 80C pack, this quad is a rocket ship. From a solid hover, a blip of full throttle puts you up at least 100 feet before you can get out of it and bring her back down.

Responsiveness is something at which the QAV-XS excels. It is quick and nimble. The stretch X design handles well and carves the turns. Using Betaflight (or your preferred firmware), you can tune this quad to be as smooth or erratic as you desire. With the proper amount of RC rates and expo, you can make this a smooth-flying machine that will still perform quick flips.

lumenier.com



Lumenier QAV-R

\$115 | Advanced

The QAV-R kit comes with all the frame parts and bolts as well as the Lumenier 4Power distribution board. Pilots will have to add their own camera, video transmitter, motors, speed controls, flight controller, battery, and receiver. The quad is available in three different versions, with 4-, 5-, or 6-inch removable arms (we tested the 5-inch ones). This model features a thicker 2mm top plate and improved removable center X-arm design; this increases the frame strength and also allows the pilot to make a quick arm change during a race if needed. Some nice touches to this quad are the grommet-holding method for the battery pigtail as well as the cutout and mounting design for integrating the video transmitter into the frame; this setup allows the pilot to easily change the video transmitting signal and works perfectly with the Lumenier TX5G2R Mini 200mW transmitter.

lumenier.com



Lumenier QAV-X Charpu

\$90 | Advanced

This symmetrical X, lightweight, super-stiff, finely tuned airframe is designed for high performance FPV drone racing. The QAV-X was created in collaboration with and named after the world-famous Lumenier team pilot Charpu. This racing airframe is stripped down to the bare essentials without sacrificing strength and durability. This version features the ultra-durable 4mm carbon-fiber main unibody plate.

lumenier.com

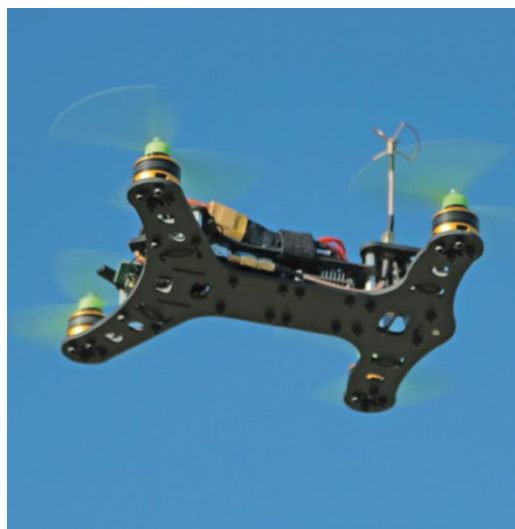


Quantum Outlaw 180

\$167 | Beginner-Intermediate

The Outlaw 180 is a stable and easy-to-fly quad with recommended settings. In this mode, the response was mellowed out a bit and didn't let you get too far ahead of yourself. The Outlaw isn't slow by any means; even with full stability and mellow settings, this thing still rips! The controls were smooth and do exactly what you want them to do when you want them to, which makes this quad a lot of fun to fly. The Quantum Outlaw 180 is a solid little package. It is quick and easy to get ready, and it has plenty of space for FPV gear. That, combined with the performance, makes it a great drone to start racing FPV.

hobbyking.com



Open 250 CK250

\$129 to \$1,989 | Beginner-Intermediate

The CK250 is the world's first carbon Kevlar drone! The frame is precision machined, lightweight, high tensile, and impact resistant—designed, engineered, and made in the USA. Also available in high modulus, quasi-isotropic carbon fiber. Sold as frame-only, DIY kit, or professionally tuned iRTF (instantly ready to fly). CAD files, schematics, and component list are available on the website.

open250.org

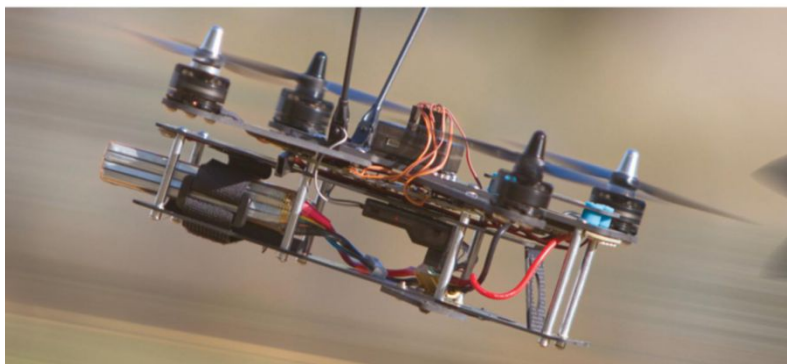


RISE RXD250

\$200 | Beginner-Intermediate

As we all know, crashing goes hand in hand with drone racing. Of course, there's always a little more crashing when you're learning, and that's where the RISE RXD250 comes in. Made out of carbon-fiber and foam, the layout is open yet still protected. All the key components are surrounded by foam, plastic, or carbon fiber, so there isn't much risk of damaging anything expensive. For a drone that is built to withstand more crashes and hits, we were impressed with how well the RXD250 handled. It's easy to fly and the controls are smooth, but it still has the juice when you want it.

explore-rise.com



RISE RXS270 Rx-R

\$250 | Beginner-Intermediate

This large-size quad will be a bit slower than the smaller racers, but it makes up for it in control and stability when flying smaller, tighter courses where the speed advantage is diminished. The easy assembly requires no soldering or programming to get it in the air, so this is the perfect quad for the new pilot looking to get into the sport of drone racing. If you want to make this an FPV bird—and you do—you will also need an onboard camera and video transmitter. In addition, you will also want an FPV monitor or goggles to receive the video transmission. The RISE RXS270 has enough room on it to offer different location spots for the flight controller (included) and the radio receiver. You can keep everything inside the body cage or place some items on top. If you keep everything inside the body (receiver, flight controller, and battery), it will provide some protection if you happen to make a rough landing or two. But it will get crowded, especially when adding the camera and video transmitter. The other good thing is that it will keep the center of gravity low and offer a little better handling.

explore-rise.com



RISE RXD250 BL Rx-R

\$150 | Beginner-Intermediate

Stripped down, light, and made out of high-impact foam and carbon fiber, the RISE RXD250 BL Rx-R lets you cut in close to every obstacle and compete in the craziest and scariest courses. Go ahead and push it! This model is designed to withstand a crash—and to go fast. Vivid LEDs make it easy to see the RXD250 BL Rx-R in low-light flight. It includes a camera mount optimized for FPV racing and requires a 5-channel radio, 3S 1500-1800mAh battery, and optional FPV camera.

explore-rise.com



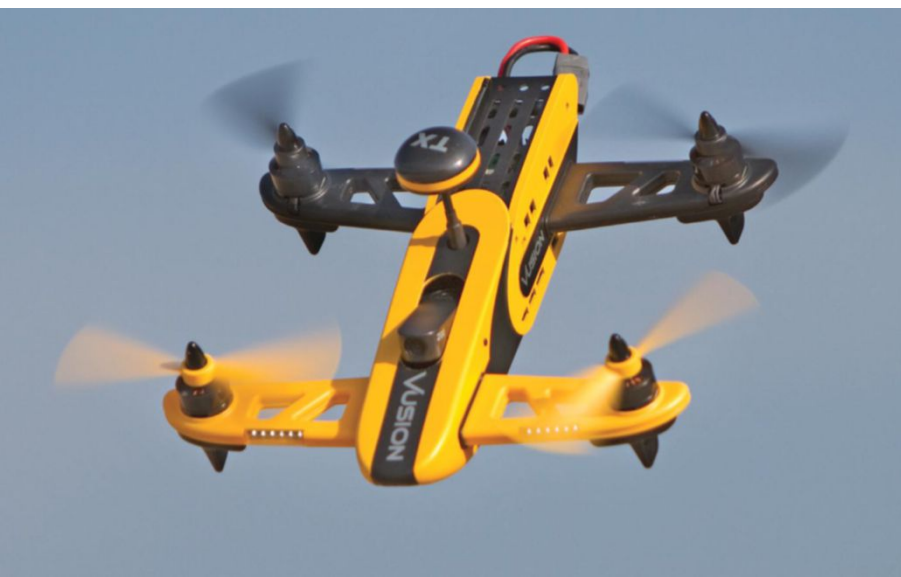
RISE RXS255 Rx-R

\$400 | Intermediate-Advanced

"RXS" stands for "RISE eXtreme Speed," and the company isn't kidding. This thing can haul! It is very responsive and definitely not a beginner's drone. There are three flight modes programmed into the control board's factory settings, which are controlled by a fifth-channel three-way switch on your transmitter. The first is Stability mode, which limits the amount it can tilt and also levels itself when the controls are centered. Position two is FPV mode; it does not level itself, but it is not overly sensitive and is great for courses that are a bit more open and flowing. Then there is Acro mode; as the name implies, this is where things are "turned up to 11"—roll and pitch rate are very fast. All these settings can, of course, be fine-tuned to your personal liking using LibrePilot.

The RXS255 is completely assembled, and all you need to do is install a 5+ channel receiver and provide your battery and, of course, some sort of goggles or monitor. The chassis is made out of carbon fiber with a few aluminum and brass standoffs. RISE designed this quad for racing, which means that sometimes you might have to disassemble it for the inevitable repair. Little things, like brass mounting-screw inserts in the plastic body, show that RISE intended this to be raced, not babied, and the whole thing is modular, making it easy to replace damaged parts.

explore-rise.com



RISE Vusion Extreme FPV

\$350 | Beginner

The hobby/sport of drone racing is exciting and challenging. Acquiring all the equipment that plays nicely together can be a chore in itself but not with this setup, which is basically plug-and-play. A short and simple calibration process has the Vusion up and flying within a minute. The transmitter has dual rates, which allows for more stability or agility as well as a switch for flight modes. Mode 1 is the most stable, features self-leveling, and allows the aircraft to tilt up to approximately 30 degrees. Mode 2 also has the auto-level attribute but now permits up to a 45-degree tilt. Mode 3 disables the self-level feature and lets the model fly at any angle and perform aerobatics. All modes feel solid and are tuned quite well from the factory.

explore-rise.com

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RISE Vusion House Racer

\$180 | Beginner

The concept behind the Vusion House Racer is to take the excitement of FPV racing and shrink down the size and price to make it more accessible for indoor fun. It even comes with a display module included, so you literally have everything you need to experience FPV right in your own living room. You can make a race or obstacle course out of normal household items, but RISE also offers its own racing gate system that's perfectly scaled to the House Racer. This quad has three flight modes, and it is impressively stable in modes 1 and 2, especially given its size. Mode 3 puts the stability solely in the pilot's hands, so have your skills sharp. If you get in over your head, don't worry too much—the House Racer is also durable. This little racer brings a new dimension to FPV and makes a great complement to your stable of conventional racers.

explore-rise.com

Thrust UAV Riot 250R Pro

\$549 | Intermediate

This is another quad that we got in right before press time and only had one chance to get out and get a couple of flights on it. We have to say that this is an impressive bird, and we look forward to more flights and really testing the Riot out on a racecourse. It comes fully assembled with all the motors, speed controls, video camera, and transmitter installed. All that it requires is a FlySky Taranis, Futaba, or Spektrum receiver and transmitter. Add one 1300mAh battery and you are ready to go. Once in the air, the Riot 250R really moves and is a solid flier that's easy to control and responsive to stick inputs. Our first impressions are very good; we like this competitive racer a lot.

thrust-uav.com



EQUIPMENT INCLUDED

Brand	Model	Price	Difficulty Level	Size	Prebuilt	Motors/Controller	Radio	Battery	FPV Camera	Display	Goggles	Stability Control
AimDroix	XRay	\$400 to \$500	Intermediate	225	Y	Y	N	N	N	N	N	Y
Ares	Z-Line Crossfire	\$350	Beginner	280	Y	Y	N	Y	Y	N	N	Y
Blade/Horizon Hobby	Conspiracy	\$350 to \$380	Beginner-Intermediate	180/220	ARF	Y	N	N	Y	N	N	Y
Blade/Horizon Hobby	Mach 25	\$430	Beginner-Intermediate	250	Y	Y	N	Y	Y	N	N	Y
Blade/Horizon Hobby	Vortex 150 BNF	\$320	Intermediate	150	Y	Y	N	N	Y	Y	N	Y
Connex	Falcon	\$799	Beginner	190	Y	Y	Y	Y	Y	N	N	Y
FPV Model Racing	#7	\$849	Intermediate	280	Y	Y	N	N	Y	N	N	Y
Graupner	Alpha 250Q FPV ARF/RTF	\$300 (ARF); \$549 (RTF)	Beginner-Intermediate	250	Y	Y	Opt (RTF)	Opt (RTF)	Y	N	N	Y
Hitec	QuadRacer 280	\$400	Beginner	280	Y	Y	Y	Y	Y	Y	N	Y
Hitec	Vektor 280	\$270	Beginner-Intermediate	280	Y	Y	N	N	Y	N	N	Y
HobbyKing	Black Widow FPV Racer RTF	\$193	Intermediate	260	Y	Y	Y	Y	N	N	N	N
Kyosho	Zephyr	\$219	Beginner	235	Y	Y	Y	Y	N	N	N	Y
Lumenier	QAV180	\$75	Advanced	180	Kit	N	N	N	N	N	N	N
Lumenier	QAV250	\$330	Intermediate-Advanced	250	Kit	Y	N	N	N	N	N	Y
Lumenier	QAV-R	\$115	Advanced	180/220/270	Kit	N	N	N	N	N	N	N
Lumenier	QAV-X Charpu	\$90	Advanced	222	Kit	N	N	N	N	N	N	N
Lumenier	QAV-XS	\$85	Advanced	222	Kit	N	N	N	N	N	N	N
Open 250	CK250	\$129 to \$1,989	Beginner-Intermediate	250	Kit or RTF	Opt (RTF)	Opt (RTF)	Opt (RTF)	Opt (RTF)	Opt (RTF)	Opt (RTF)	Opt (RTF)
Quantom	Outlaw 180	\$167	Beginner-Intermediate	180	Y	Y	N	N	N	N	N	Y
RISE	RXD250	\$200	Beginner-Intermediate	250	Y	Y	N	N	N	N	N	Y
RISE	RXD250 BL Rx-R	\$150	Beginner-Intermediate	250	ARF	Y	N	N	N	N	N	Y
RISE	RXS255 Rx-R	\$400	Intermediate-Advanced	257	Y	Y	N	N	Y	N	N	Y
RISE	RXS270 Rx-R	\$250	Beginner-Intermediate	270	Semi	Y	N	N	N	N	N	Y
RISE	Vusion Extreme FPV	\$350	Beginner	250	Y	Y	Y	Y	Y	Y	Y	Y
RISE	Vusion House Racer	\$180	Beginner	120	Y	Y	Y	Y	Y	Y	Y	Y
Thrust-UAV	Riot 250R Pro	\$499	Intermediate	250	Y	Y	N	N	Y	N	N	Y

FINAL THOUGHTS

There are more quality racing drones available today than ever before, and balancing price, features, and required skill level can be a challenge. We hope the info we have presented here will help you do that. Of course, selecting the right racing drone will come down to a mix of factors—and speed is only one of them. One of the most famous adages in racing says, “To finish first, first you must finish!” Your talent and preparation are every bit as crucial as your outright speed. Having a drone that feels comfortable, one

that matches your flying style and experience level, and one that you can count on to make the race distance every heat will earn you better finishes. And the more laps you complete successfully, the more it will help you hone your skills and make you a smarter, better racer—which will make you faster without changing a single piece of equipment. So if you want to develop that winning edge, choose a reliable drone that suits your style and experience. We'll see you out on the track! ➦

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LET'S TALK GIANT SCALE

TEXT & PHOTOS BY JOHN GLEZELLIS



By employing a few practices discussed this month, you can perform low-level, knife-edge passes with minimal corrective inputs. Shown here is the Flex Innovations 70cc Mamba.

Proper trimming and programming for a better-flying plane

Over the years, advancements like the use of a single-axis gyro and stabilization systems like Horizon's AS3X have made flying more enjoyable. But no matter what type of aircraft is being flown, each model may exhibit a trait that you may not desire or—even worse—fear! It's important to recognize that there is no substitution for proper trimming and programming practices.

This column will provide a basic overview of a model's mechanical setup and also touch upon a few ways in which you can leverage your computer radio system. The goal is to eliminate inconsistent trim performance, adverse yaw, and certain pitching tendencies that occur when a given control surface is deflected. To do this, you must first understand how to analyze your airframe and the process with which to test and address each issue. Let's begin!

THE PROPER FOUNDATION

Every decision you make throughout the build will have an impact on the aircraft's overall performance. On the mechanical front, these choices include but are not limited to the proper

selection and installation of all servos and their respective linkages in addition to having the correct wing and tail incidence angles. While programmable mixes can help, they are often considered "Band-Aid" fixes. Let's see why.

The servos on an airplane must have a sufficient gear train to prevent failure, torque to prevent what is called "blowback," and precise centering abilities. Blowback is when the servo loses holding power as pressure is applied on the surface. To illustrate this, while you may see 45 degrees of control-surface deflection on the ground, once in the air and at a reasonable flight speed, the surfaces may only move a fraction of that amount! For ailerons, it is impossible to tune the differential amount when the servo has inconsistent travel

points from flight to flight and while traveling at different speeds. If this is the case, blowback might be the cause, and you won't be able to precisely tune your model to eliminate the yawing or pitching tendencies noted earlier. Several online spreadsheets as well as a few online torque calculators allow you to enter basic information to determine whether your servos have enough torque to prevent blowback. Additionally, you should connect servos in a way that supports differential. It is quite common for many sport models to use either a single servo to control the ailerons or two servos, with the use of a Y-harness, to connect them to a single port on the receiver. If you do this, you won't be able to program the differential.

Next, make certain that the linkages are sufficient for your aircraft. In a push/pull configuration, I prefer to use heavy-duty aluminum servo arms that allow me to use a titanium Hangar 9 Pro-Link secured with Du-Bro's heavy-duty 4-40 ball links. If your biplane has a slave aileron that is connected to the master aileron by a pushrod, make sure



When an airplane uses dual ailerons concealed within the wing, it is often easier to program and verify functionality with the servos exposed. If each aileron servo is connected to a different receiver port, you can program the differential.



Use of an incidence meter, like this one from Hangar 9, allows you to precisely adjust and verify the wing and stabilizer incidence angle as well as the engine's thrust angles.

there isn't any slop within the attachment points as well as within the servo, servo arm, and control horn. Similarly, make certain that the linkage will not flex under a simulated load. Never use fully threaded pushrods unless they are installed in a carbon-fiber or similar sleeve with metal nuts at each end to firmly secure the sleeve in place.

With the servos and linkage installed and properly connected, the next step is to program each servo. While it may appear obvious that control-deflection angles must be correct, I cannot begin to tell you the amount of times I have flown an aircraft and found that the right and left ailerons differed with respect to their maximum travel amounts. Using a digital angle meter is beneficial, but at a minimum, the use of any measuring device is sufficient. Be sure the deflections are identical before you program the differential so that you know exactly how much deflection you have and

that each percentage change in the differential function obtains an accurate deflection from the desired control surface.

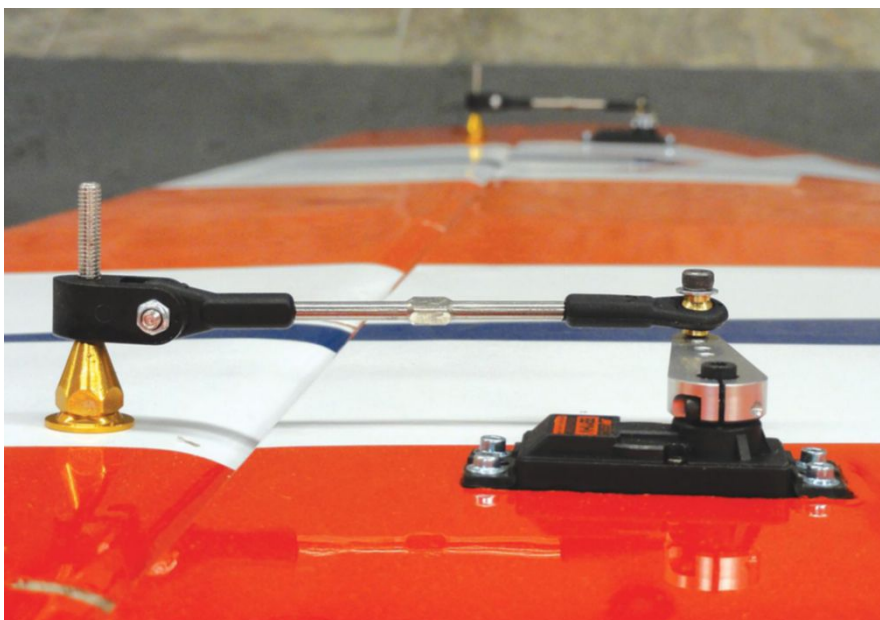
Some manufacturers offer aileron-deflection amounts that incorporate differential. Set the maximum travel points within the adjustable travel volume (ATV) or endpoint adjustment (EPA) functions so that travel is equal and matches the maximum amounts given by the manufacturer. Then, use the differential program to tune all settings. Never change the ATV or EPA settings to result in the desired differential amount as severely different percentages will change how the servo responds to a given command.

Testing for differential will differ between different model types. With a slow-flying scale model, many sport pilots typically turn by applying a touch of aileron input followed by up-elevator. If they don't use differential, the increased drag on the down aileron will result

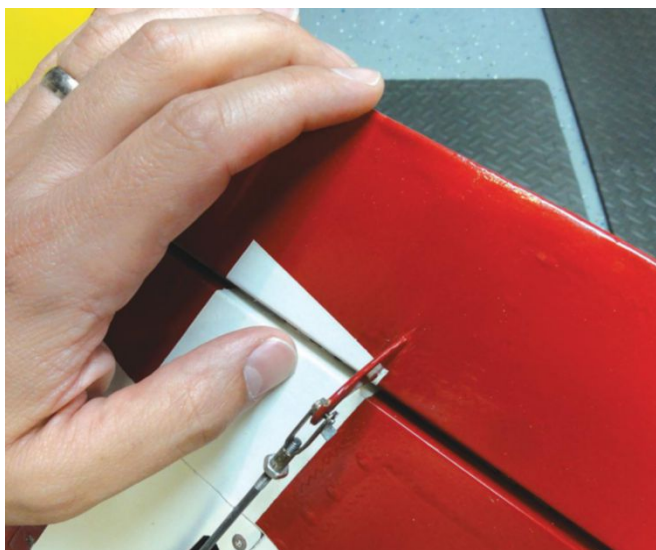
in a yawing tendency in an adverse direction to the desired turn because a greater amount of drag exists on the wing opposite the turn. With an aerobatic model like the 70cc Mamba biplane, I prefer to perform two different tests. First, I climb to a high altitude, pull the throttle to idle, and push to establish a 90-degree downline. I then apply full left aileron input and note any tendency for the aircraft's nose to move. Another test is to apply maximum power, pull to a 45-degree upline, and apply full left aileron input to perform a roll or two. If the nose wanders to the left, you need to reduce the downward-moving aileron with differential; similarly, if the nose wanders to the right, reduce the amount of up-aileron travel with differential. The goal is to perform a roll, or multiple rolls, so that the aircraft will stay on the same vertical climb. If you prefer to perform the 45-degree climb test, limit the number of rolls performed. Airspeed may drop over time, and depending on the power-to-weight ratio of your aircraft, this will have an impact on what differential value you feel is necessary.

Typically, you want more up-aileron movement compared to downward movement. Different hinge methods decrease the amount of adverse yaw, but while most center-hinged airplanes need differential that results in having the top aileron move more than its downward deflection, some composite airplanes that have top hinges need reverse differential (the aileron will travel more down than up as the control-surface area differs from the top surface to that of the bottom surface). You can mechanically change the placement of the linkage attachment point to incorporate aileron differential into an aircraft. The more you advance the servo-arm neutral position, the higher the differential effect on the ailerons. With an advanced computer radio, the easiest way to incorporate aileron differential is to apply a certain percentage in the "aileron differential" program.

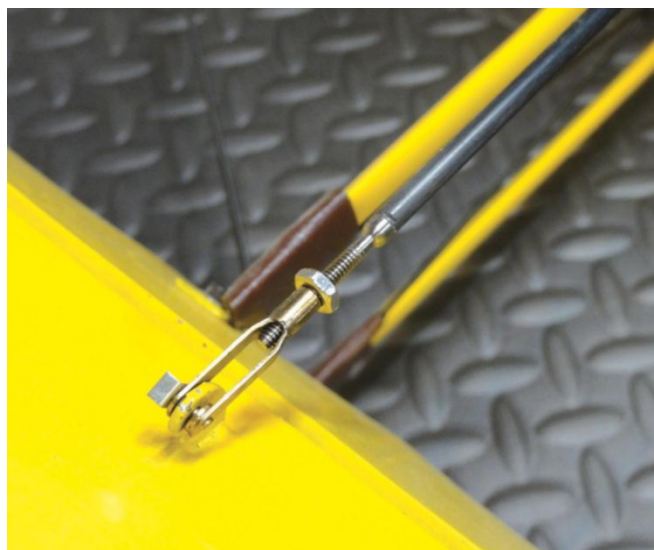
With the assumption that the construction of the aircraft is structurally sound, with



Use of heavy-duty ball links and titanium turnbuckles offer a direct-linkage configuration.



Hold the trailing edge of a given control surface and apply small movements to ensure that no undesired movement is exhibited. If any slop is present, isolate and address the cause.



You can use a clevis for certain applications. Here, you see the aileron connector rod attached to the top surface of the biplane's bottom aileron.

no excessive twist on the control surfaces, it is time to begin the fine-tuning process. For the plane to fly well, you must ensure proper incidence angles for the wing(s) and the horizontal stabilizer. All reputable kit manufacturers state the proper incidence

angles for their models. If this is not the case, it is important to seek advice. Typically, you will begin with the incidence angle between your wing and stabilizer so that they are parallel to one another and that the engine is also aligned. Then, take to

the skies to trim the model.

With a pure aerobat, you should be able to perform a vertical dive in which the aircraft tracks completely vertical. If it demonstrates any pull or push, however, increase or decrease both the wing or stab incidence angles. With a



When a biplane has two ailerons connected to one another, proper geometry in the linkage allows both ailerons on a given side to move the exact same amount.

biplane, you may notice that your control trims change in flight, especially in roll. Wing rigging, if applicable, can loosen in flight. Similarly, an interplane strut may develop some slop or something similar, as can the gear train of a servo. Address all items, which include tightening the wing cables, if applicable, and monitor any servo or linkage slop.

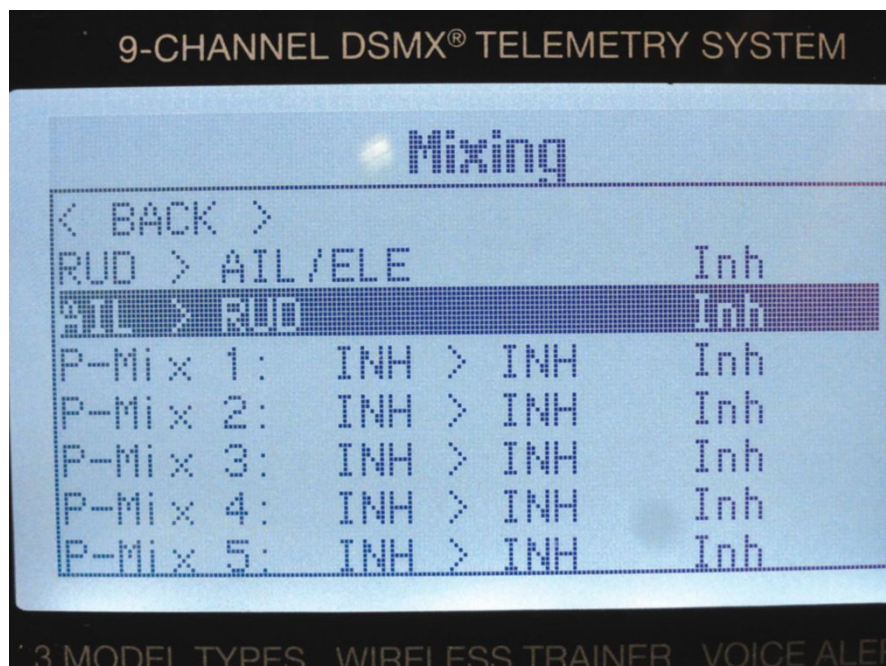
PROGRAMMABLE MIXING BASICS

Advanced radios offer programmable mixing capabilities that can prove beneficial in different ways but may also serve only as Band-Aid fixes. Common mix types are linear or a multipoint curve mix. Linear mixes allow for a fixed maximum amount, but a curve mix lets you adjust the mix from point to point over the full range of the movement for a given control surface. You can command, for example, precise rudder deflections to coordinate the nose of the aircraft in the turn when you apply small amounts of aileron. When you apply larger amounts of aileron to execute a roll, though, the mix can return to 0% so that no rudder is automatically applied and the plane performs a clean roll with no automatic yaw input.

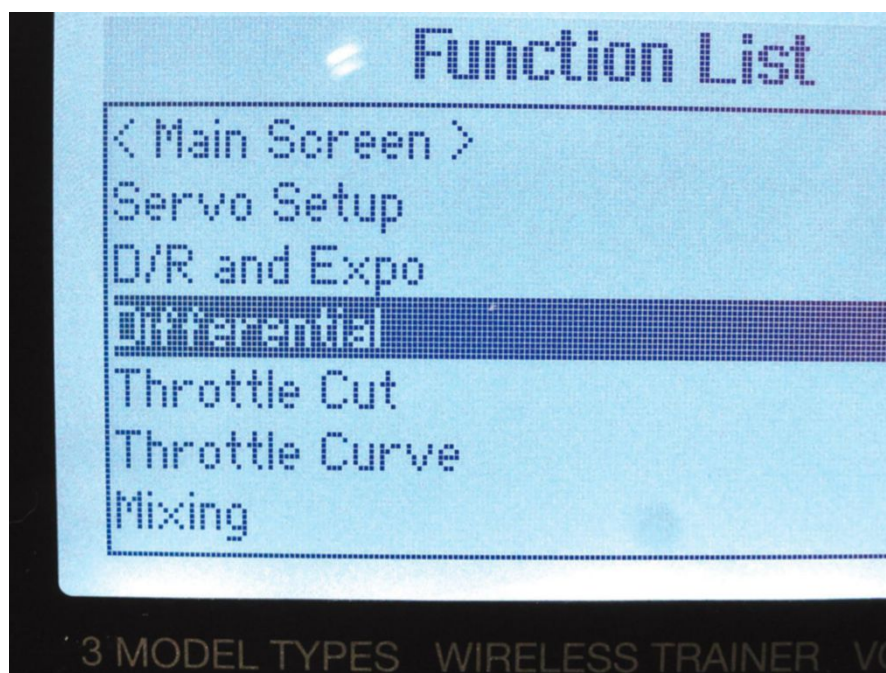
Some transmitters offer a default "aileron-to-rudder" mix. In this preassigned programmable mix, rudder is automatically applied with any aileron deflection to keep the aircraft in a coordinated turn. This mix is beneficial for those pilots who may find it challenging to apply rudder input. If your radio does not feature this mix, it is quite easy to accomplish. The "master" channel is the control surface that is being deflected, and the "slave" channel is the control surface for which you want the automatic input. Always assign the mix to a switch, if needed, or have it active throughout the entire flight. As with all changes, modifications should be made in small increments so that you can fly the model and note the result.

Aerobatic enthusiasts may notice a pitching tendency whenever the model performs a four-point roll or knife-edge flight whenever rudder is input. If the airplane pushes to the undercarriage, use the "rudder-to-elevator" mix. In this case, a small percentage of up-elevator is needed. You want the aircraft to remain neutral and not to push to the undercarriage when you add rudder. Similarly, if your airplane also rolls while in this attitude, use a "rudder-to-aileron" mix.

Different centers of gravity will also change the overall mix percentage required. Some pilots, however, prefer to use "throttle-to-rudder" mixes to correct for an incorrect engine thrust angle or a "throttle-to-elevator" mix to tend to an incorrect incidence angle. Take the additional time to trim the aircraft, obtain the correct amount of right and up



Many radios offer multiple mixing options. Shown here is the mixing selection screen found on the Spektrum DX9.



Proper use of the differential function, seen here on the DX9, will eliminate certain undesired traits that are discussed here.

or down thrust, and enjoy your model's pure characteristics.

FINAL THOUGHTS

In closing, it is important to understand not only your ability as a pilot but also the capabilities of the aircraft that you are flying and how you can address certain undesirable flight characteristics. While electronic advancements like using a single or three-axis stabilization

system may prove beneficial, they are never a substitute for poor assembly. For consistent flight performance, you need a properly built model that incorporates the items discussed here. Use this column as a basis to improve your understanding of proper setup techniques, and most important, enjoy every part of this great hobby and seek out every learning experience possible. ✚

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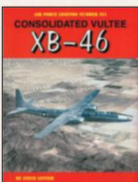
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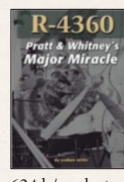
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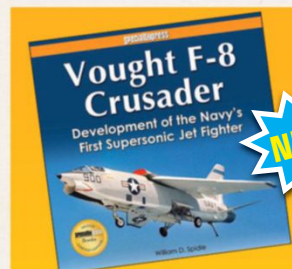
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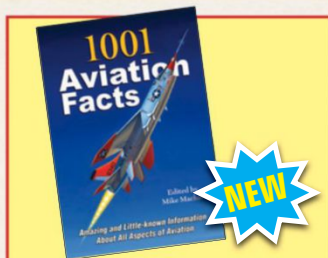


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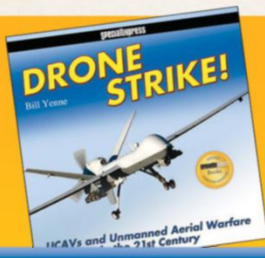


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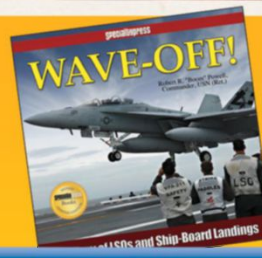


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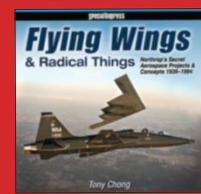


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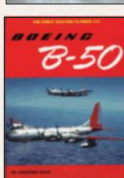
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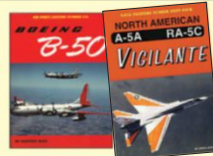


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Mufflers, Multi-Cylinders, and More

[Q&A] Email your questions to Clarence Lee at MAN@airage.com.

It seems like, lately, a month or two seldom goes by in which one of the major hobby-related businesses doesn't close its doors. In the past six or seven months, Fox Manufacturing ceased operation, as did Hobby People with their multiple stores and Macs Products, the country's largest manufacturer of mufflers, tuned pipes, header pipes, and related accessories. It was back in the

one combustion cycle). In the case of a 5-cylinder radial, the number one cylinder fires, skips number two, and number three fires, etc. On the second revolution, number two fires, followed by number four, and back to number one. Since the engine fires one cylinder and then skips one, there has to be an odd number to come out even. Radial engines use a master rod, with the other rods connected to the master rod and a single throw crankshaft. Opposed engines use a double- (or more) throw crankshaft depending on the number of cylinders (i.e., a throw for each pair of cylinders).



Macs Products' universal muffler is available for .20- to .60-size engines with either a strap-on or bolt-on retainer, depending on the engine.

DAMAGED FOUR-STROKE

Our next letter from Canadian Ed Carew was accompanied with two

photos, neither of which was suitable for reproduction. Basically, they showed a piston with a big hole in the center and both rocker arms broken. Ed's club members felt the damage was caused by a stuck valve, but he disagreed and asked for my opinion. Read on.

mid-1960s that the change from .45ci engines to .60 size for pattern competition was underway. Due to the larger engines, noise became a problem at many flying sites, and many clubs began looking into mufflers as a solution. Wally McAllister foresaw the future and formed his business, Macs Products. After more than 40 years, Wally decided to retire and turn the business over to his brother, Dave. This past September, however, Dave unexpectedly passed away. When no other family members were interested in continuing the business, Dave's wife put it up for sale. My good friend Randy Linsalato, who in conjunction with his wife, Anching, own and operate MECOA/K&B, purchased Macs Products. Randy does not intend to continue any production, but he did receive a large inventory of the products that he will be making available. So if you are in need of any of the Macs Products' line of mufflers and pipes, visit mecoa.com or call 626-359-6972.

Now to the letters.

MULTI-CYLINDER RADIALS

✉ I am wondering if you could enlighten me and your readers about the design of multi-cylinder engines and, in particular, radial engines. Why do radial engines always have an odd number of cylinders? The only even number multi-cylinder engines I have seen are always opposed.—Frank Jordan, Kansas City, KS

Answer: Well, Frank, as most people with any engine experience know, a four-stroke engine fires every other revolution (i.e., two revolutions for

✉ I have been reading your columns for more years than I can remember, and this is the first time I have written to you. The subject matter is a 15-year-old Saito .56 engine that quit abruptly in flight. The engine had previously been very reliable in a number of different models, including a Telemaster, Unionville Beaver, and Kaos 40. There has been a lot of discussion in our club regarding the cause, with "stuck valve" being the most popular view. I have a problem with that since it does not explain the damage. I think the valve broke off the valve stem, bounced around the combustion chamber and made a hole in the piston, jammed the exhaust valve (thereby breaking the rocker), then was pushed up into the intake port, which pushed the valve spring assembly out and broke the other rocker. This would account for the damage, but what would cause the valve to break off the stem, and what would cause the retaining clip to break and the top of the valve stem to break off? With your many years of experience, I am hoping you can provide an explanation of what might have caused this failure. Note: I don't think it is worth repairing the engine; I'm just curious about what happened.—Ed Carew, Carleton Place, ON, Canada

Answer: Ed, in my opinion, I believe your assessment is entirely correct. The damage had nothing to do with a stuck valve. You did not say how much fuel had passed through the engine, but having seen use in three aircraft, it was probably a lot. During that time, it more than likely saw some lean running, particularly toward the end of a flight, resulting in detonation. Detonation is a well-known cause in the automotive and full-size aircraft fields for breaking valves and pistons.



The 1945 Morton M-5 was the first radial engine to be marketed for model aircraft use. It weighed only 22 ounces and developed about 0.5hp at 3,500rpm. It was modeled after the full-size LeBlond engine and was developed during World War II as a training aid for aircraft-engine mechanics.

STUCK WRISTPIN

Our next letter is a little on the long side, but expresses a problem that I am sure many of our readers have experienced when trying to disassemble an engine for cleaning.

✉ I have read all of your Engine Clinic articles, starting with the first one way back when, and also your various books on engines. I have had a problem with an old Super Tigre .51BB engine, which I would like to get your advice on. I cannot recall your ever addressing this issue, except to mention that, on this type of engine, the wristpin must be pulled out with a wire using a hook on the end. It would appear that this engine was given Rislone after-run oil many years ago, as it has greenish marks. I would guess that the engine has not been used for more than 25 years or more. The engine was nearly stuck but would turn over. I put 3-in-1 oil in it, and it freed up pretty well. The cylinder sleeve came out fairly easily.

Then came the problem. First, I tried using the wire to pull the pin but could not even get the end pad out, even after heating the piston. I inverted the engine and filled the piston cavity with WD-40 and let it soak overnight, with no success. I tried heating it several times—again, no success. The rod was loose on the wristpin, so the pin had to be stuck

in the piston. I also tried your carriage bolt trick to pry the rod off the crankpin, but there was not enough slack as it would only come about a third off and I had to tap it back into place. I then turned to a drastic method. I carefully drilled a hole in the front of the case at exactly the same position as the back hole. I used a slim flat-head punch through the front hole and carefully tried to tap the pin out, but it would not move. I then used a press and finally got the pin to move. It took considerable force to push the pin out of the piston. I was concerned that the pressure used might distort the piston, but it seems to be OK. After cleaning the piston and wristpin, they seem to have the proper slip fit, so it seems that the pin was stuck with dried oil.

Do you think the Rislone could have possibly caused the stuck pin? I have not encountered this problem in any of my engines that have been stored with Rislone. Do you have any ideas as to how to remove a wristpin that is as stuck as this one was? I would appreciate any thoughts you have on this problem. I know you can cut the rod and get the parts out, but with no replacement rod, that is not something to do.—James Leisk, Shreveport, LA

Answer: Jim, I can sure relate to your wristpin experience as I have run

TIP OF THE MONTH

Every month, I usually have four or five engines pass through my hands for a stripped glow plug or four-stroke exhaust thread repair. It is surprising how many of the engines' prop drive washers have been mangled by being held with

regular pliers, especially the four-strokes. It was back in the January 2013 column that I brought to your attention a nifty pair of channel-lock-type pliers with nylon jaws. The tool was being sold by Micro-Mark and was really great for grabbing an engine's prop drive washer to keep it from turning when tightening the prop without damaging the drive washer. This



past April, I decided to give my son a pair for his birthday only to find out that Micro-Mark no longer has the pliers. But I now have good news. I imagine that most of our readers, like me, receive a large number of merchandise catalogs, which just get thrown away. This past month, however, I was thumbing through one called "Whatever Works" while my wife was making lunch when I saw—guess what!—a dandy pair of plastic channel-lock-type pliers with rubber jaws similar to those discontinued by Micro-Mark. So, rather than butcher up your engine's prop drive washer with regular pliers, get yourself a pair of these rubber-jaw pliers, called "Power Grippers." They are a bargain at only \$9.99 (plus shipping) and should be in every modeler's toolbox. To order, visit whateverworks.com or call 800-499-6757 and ask for part no. KF6-634.



Above: Power Grippers, available from Whatever Works, is a tool for every modeler; you should have a pair. Below: The result of using regular pliers to keep the engine from turning when tightening the prop is obvious in this photo of a typical prop driver.

into this many, many times over the years. If you ever run into this problem again and can't remove the wristpin with the tip of a bent pin, use the tip of a round jeweler's file jammed into the wristpin hole. If this still doesn't work, the end pad will have to be drilled out. Then using an Easy Out, available at any hardware store, will be required. Easy Outs usually come in a set of four. Easy Out, along with heat, will usually get the wristpin out. Rislone is a good oil to use for long-term storage but, like oil, will eventually harden. I do not like it for an after-run oil as exhaust residue will stain white or light-colored paint when the engine is run. I have found automotive automatic-transmission oil to be much better for long-term storage, and when mixed 50:50 with Marvel Mystery Oil or Air Tool Oil, it's an excellent after-run oil.

MULTIPLE ENGINE FAILURES

✉ I have been flying RC aircraft for about 16 years, mostly with O.S. two-stroke engines. All was going well until about a year or so ago when I started to have multiple engine failures. Up until that point, I was the envy of our flying-club members as I rarely crashed an airplane and still have, and occasionally still fly, my original SIG Kadet trainer with an O.S. .46 engine. Last summer, I totaled three very nice airplanes, severely damaged another one, and managed to dead-stick glide a few more back to the field with no damage. In all cases, all of these glow engines (five different O.S. engines and one Evolution) just stopped dead, usually in level flight. I have no idea what's going on! Any suggestions? I love the RC aircraft hobby, but all this is leaving a sour taste in my mouth. —Dick Parkes, Kamloops, BC, Canada

Answer: Dick, if you experienced the same problem with five different O.S. engines and an Evolution engine, which have proven to be some of the most reliable on the market, you obviously have a common problem that you are overlooking. Two-stroke glow engines are pretty simple in operation, and if they're mechanically OK and supplied with fuel and ignition, they are going to run. In your case, I would have to guess that it is a fuel-related problem. I believe your problem is either a stiff pickup line in the fuel tank that is not following the fuel as the tank empties or you have a blocked or pinched muffler pressure line creating a vacuum as the tank empties that, in turn, stops the fuel flow.

INTAKE AIR LEAK

✉ I am trying to catch up with my reading and just finished reading your column in the February 2017 issue. The "Hard Start" section drew my attention as I have run into this difficulty before and found that the source of the problem was air leakage in the intake header/manifold downstream of the carburetor. The engine would run quite well at top speed but would lean out at idle to the point of being impossible to start at that throttle setting. Thanks for all the valuable knowledge that you have been passing on to your readers over the past 48 years. —Guy Lemieux, via email

Answer: Thanks for sharing your experience with us, Guy. It is always appreciated when our readers can help us solve problems.

That does it for another one, gang. We'll be back in the December issue. ✚



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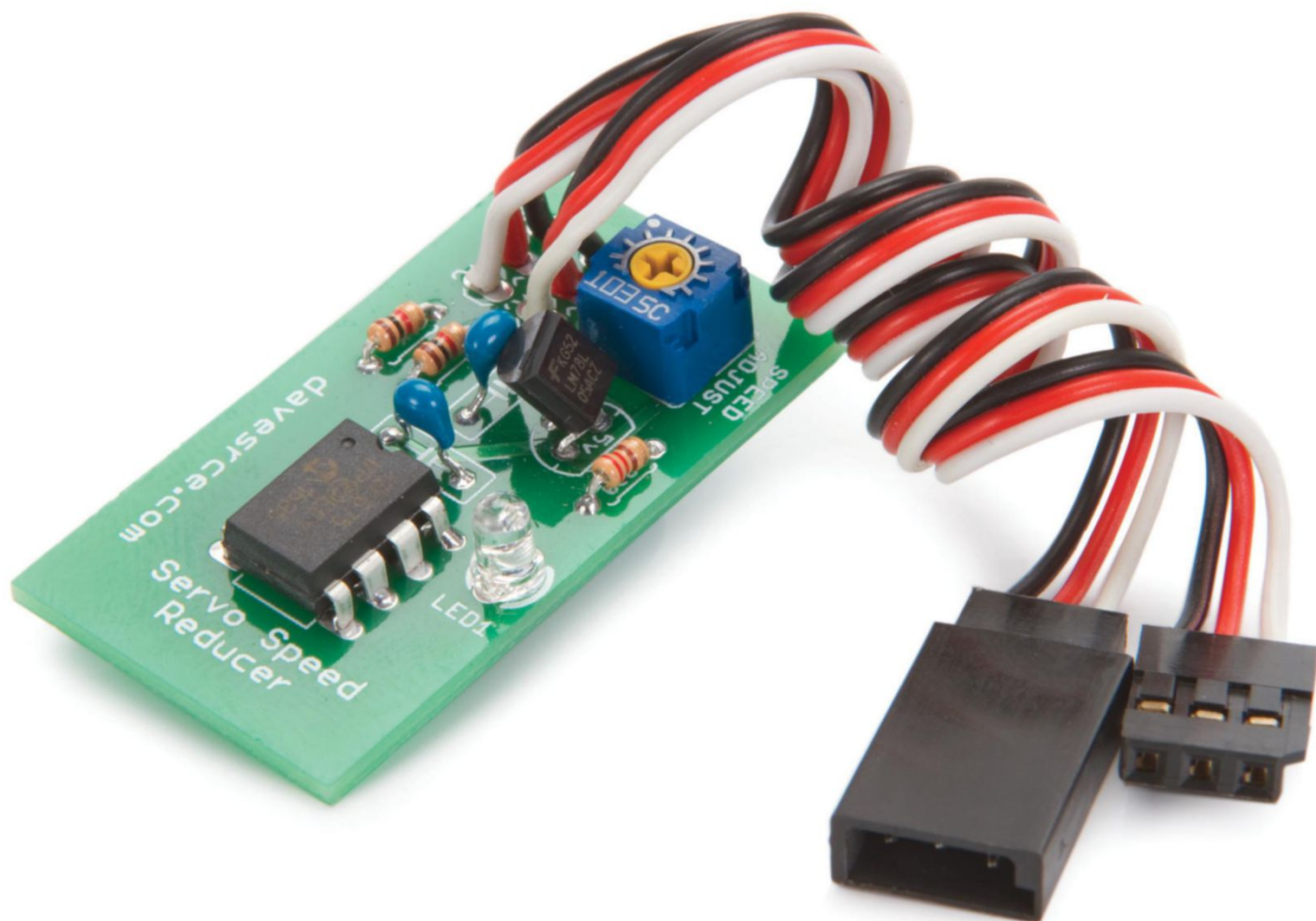
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AIRAGESTORE.COM

Product Watch

MINI REVIEWS OF EDITORS' FAVORITES



Dave's R/C Electronics Servo Speed Reducer

There are often model airplane functions that require the speed of the servo to be changed from the normal rotational response to something slower. Scale flaps are what come to mind here. With computer radios, some have programming that allows you to adjust the speed of your servos, but for modelers using basic radios, a simply plug-in device can provide an inexpensive solution. To fly your model smoothly and consistently, the motion of your flaps need to be slowed down, and that's where a Servo Speed Reducer (SSR) comes in handy. If you simply add the flap function to a two- or three-position switch, the flaps move quickly and this produces a sudden change in pitch, which has to be corrected during your landing approach.

Available from Dave's R/C Electronics, this SSR is compact and lightweight, and simply plugs into place between your flap servo and your receiver. Installation takes only seconds. It also provides adjustment for the servo's speed with a potentiometer (pot) on the circuit board.

Setting up your model is easy. After you install the SSR, make sure the receiver is off. If the unit detects power but not a signal, the indicator LED will slowly flash on and off. With the receiver off, turn the pot full clockwise and then turn on the transmitter, followed by the receiver. The LED will come on (without flashing), indicating that the servo will operate at normal speed without any speed reduction. To make an adjustment to the speed, you turn the receiver off, make the adjustment to the pot, then turn the receiver back on. This way, the device's circuit memory will accept and retain the new setting, and the LED flashes rapidly.

Some fine-tuning is required with some test flights to dial in the proper amount of servo speed reduction. By taking several seconds to lower the flaps, the abrupt change in lift is minimized and gives the plane time to settle down, smoothing out the flight path. Priced at \$15.00, this simple plug-in device works great and provides modelers with precise control over their servo's speed and performance without needing a more expensive programmable transmitter. —Gerry Yarrish
davesrce.com

With no soldering required, the Servo Speed Reducer comes fully wired and is simply plugged in between your servo and receiver.

Shapeways Aluminum 3D Printing

Shapeways has built a reputation as a leading supplier of 3D printing services to hobbyists. The New York-based company offers a variety of 3D printing technologies, allowing it to provide a range of different materials and surface finishes. Now, 3D-printed aluminum is an option. While Shapeways's standard laser-sintered nylon material is tough enough for most RC modeling applications, some high-stress components need the added strength of aluminum, and now you can have metal parts made to order.

To obtain the best possible physical properties, Shapeways employs selective laser melting, rather than lower-temperature laser sintering. By fully melting the metal, a stronger, more homogeneous part is produced. Aluminum parts can have wall thicknesses down to 1mm, although 1.6mm is recommended, and surface details down to 0.5mm are possible. Because of the strong homogeneous nature of the material, machining processes like drilling and tapping work really well.

As with other materials from Shapeways, you can upload your own 3D model and get a price quote in minutes, or you can choose from the tens of thousands of existing designs in the constantly growing designer library. Parts are typically produced in about two weeks and are shipped to your front door.



This RC car motor mount was designed by Alvin Ma (at Shapeways shop "AMAEngineering"). Aluminum 3D printing makes it practical to produce your own out-of-production parts or to design new parts to adapt upgrades to an existing airframe.

The aluminum printing process is slower and more expensive than sintered nylon, so aluminum parts cost about 10 times as much as plastic. But for high-stress applications, it's well worth the cost. —

Jim Ryan

shapeways.com



Featuring quality parts and finish, the TY1 fuel pump is a great value. You can see (above) that the inlet and outlet fittings come with protective covers.



Icare-Icarus TY1 Fuel Pump

If you are looking for a compact, easy-to-use fuel pump for your RC airplane, the TY1 rechargeable is a great addition for your field box. One inch in diameter and 4.5 inches long, the TY1 comes with a USB cord to charge its installed 2000mAh Li-Ion battery. There is a micro B charge port, and battery duration is about 15 minutes. Equipped with a small "power and fuel direction" switch, the pump is housed in a rugged, anodized-aluminum housing with a compact fuel-line attachment block at the top. To fill the airplane fuel tank, move the spring-loaded switch toward the attachment block and it remains active. For defueling, the switch is moved in the opposite direction, where it operates as a momentary switch. The TY1 is lightweight (5.51 oz.) and is easily carried in any field box for quick fills. For convenience, it can easily be attached to a fuel container or bottle with a couple of tie wraps.

Priced at \$59.00, the TY1 is specially designed to be used with glow fuel, gasoline, kerosene, or any other fuel containing lubricant oil. In use, I found that the TY1 operates smoothly and quietly, and it easily handles my glow-powered sport fliers with 10- to 12-ounce tanks. It has a flow rate of approximately 950cc/minute, so it can handle much larger tanks as well. —Gerry Yarrish

icare-icarus.com

Final Approach

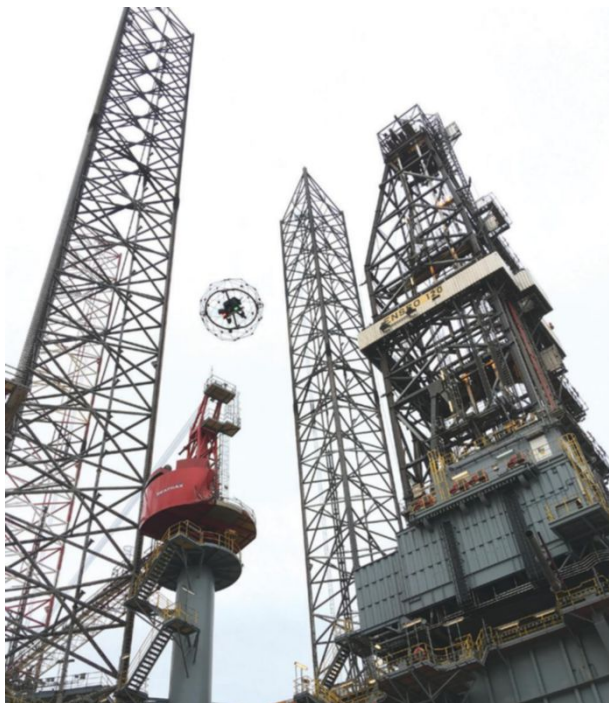
BY THE MODEL AIRPLANE NEWS CREW

All in a Day's Work

Flyability's Elios makes inspections faster and safer

Anything designed and built on a truly industrial scale—structures like bridges, dams, factories, and refineries—are vital to our everyday lives. These things are expensive to build and equally so to inspect to ensure they are properly maintained. Flyability is a company specializing in confined inspection of large structures like holding tanks and other dangerous abandoned structures. The company uses a specially designed drone called “Elios” that features a spherical and flexible carbon-fiber cage to protect it while the drone operates in confined areas. It allows the drone to literally bounce off anything it happens to bump into. Equipped with full high-definition and thermal-imaging recording, it also has powerful LEDs to let operators navigate and inspect dark places, and live 2.4GHz video feedback allows for beyond-line-of-sight operations, even in metallic environments.

Flyability notes that a typical drone-based inspection starts with a



reconnaissance flight that allows the operators to find all areas that require a closer look. According to its website, “The experience gathered through missions in boilers, storage tanks, ballast tanks, buildings, chimneys, and so on, shows that 10 minutes is sufficient for most infrastructures to perform this reconnaissance flight.” Additional flights more closely inspect defined points of interest with close-up images. Bringing the drone back to the operators after each segment of the inspection allows them to review the images in details and refine/update the inspection plan.

Recently, a refinery infrastructure company was finishing up the assembly of a radiant box, consisting of 144 40-foot-tall pipes, when quality-control concerns required the visual inspection of this highly complex environment. Scaffolding would only have made the situation worse, so the Elios was pressed into action. For the refinery manufacturer (as with all companies), time is money, so using a drone to inspect and document the structures in question saved a tremendous amount of labor. A two-person crew set up a charging station just outside the building and, using the drone's onboard lights, flew the drone to the top of each pipe and descended slowly while recording video. The work was completed and high-resolution video records for each pipe were produced in a matter of only a few days, where the inspection would have normally required several weeks. The bottom line: There was an 85 percent savings in time (when compared to manned inspection) and a 75 percent savings in cost. Safety was also greatly improved as no one had to climb high into the structures. ✈





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